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THE PHOTOGRAPHIC GUN.

THE experiments which I am going to describe are connected with researches that I made a dozen years ago, in regard to animal locomotion, and which I had to suspend; but I intend taking them up again now, and developing them further.

My first experiments on locomotion were made by means of the chronograph, and they faithfully translated the rhythms of the gaits of men and animals, that is to say, the instant of putting each limb on the ground, and the length of time it rested thereon. Later on, by a still more delicate method, I inscribed the phases of the up and down motions of the wings of a flying bird, the trajectory described in space by the point of the wing, the changes of the alar plane, and the oscillations of the body in their relation to the motions of flight.

The data afforded by the graphic method were very exact, and they corrected certain disputed questions of animal mechanics; but the ideas furnished by such a method were still incomplete. Thus, as concerns the gait of the horse, I endeavored to get a representation of the attitudes of this animal at different instants of each movement made; but the figures made from the data given by the chronograph, although

FIG. 4.—ENLARGEMENT OF AN IMAGE TAKEN BY THE PHOTOGRAPHIC GUN.

perfectly correct as regards the position of the limbs touching the ground, exhibited incorrectness as regards those raised. I had a proof of this when the beautiful instantaneous photographs by Muybridge, of San Francisco, appeared. The image of a horse, taken in 1-500th of a second, gives, even during the most rapid gait, the real attitude of the animal almost as sharply as if he had been immovable.

La Nature having published some of Mr. Muybridge's figures, I hastened to write to my friend the editor, in order to express my admiration for these beautiful experiments, and to beg him to get the author of them to apply instantaneous photography to the study of the flight of birds. I at that time advanced the idea of a repeating photographic gun analogous to the astronomical revolver invented by my confrère, Mr. Janssen, for observing the last passage of Venus. This gun was to give a series of successive images taken at different instants of the revolution of the wing; such images, when arranged on a Plateau phenakisticope, reproducing the appearance of the motion of the animals thus represented. The result of this letter was that Mr. Muybridge sent me a collection of his beautiful photographs, and assured me that he would apply his apparatus to the study of the mechanism of flight. Besides this, different authors adapted to zootropes either figures constructed after my chronographic notations, or images obtained by the celebrated American photographer, and thus got a striking representation of animals in motion.

During the month of September last, Mr. Muybridge came to Paris, bringing a rich collection of instantaneous photo-

FIG. 1.—MODE OF USING THE PHOTOGRAPHIC GUN.

graphs, which represented not only the different gaits of the horse, but man in the act of different exercises, such as running, jumping, fencing, fighting, etc. In this collection there were also a few photographs of birds in the act of flight; but it was not as it was in regard to the man or the horse—a representation of successive attitudes—but the images were analogous to those that had been obtained by Mr. Cailletet some years before, showing the wings of the bird now in a single position, now raised, now depressed, or in some intermediate phase. These photographs were, however, very interesting, for they verified what the graphic method had caused me to perceive relative to the mechanism of flight; and they promised especially valuable data, provided such images could be obtained *in series* as had been done by Mr. Muybridge with respect to man and quadrupeds.

I resolved to devote this winter to realizing my old project of a photographic gun. The gelatino-bromide of silver process made me hope for quite clear images from a very short period of exposure; but the rapidity with which the motions had to be repeated that presented the different points of the sensitized plate to the focus of the objective carried with it certain difficulties in the construction of the instrument. It was necessary, in fact, to get at least ten or twelve images per second in order to have several attitudes of the bird at each revolution of its wing. Besides, such speed was imposed on me by the project that I had formed to arrange in a phenakisticope the series of images obtained, in order to reproduce the appearance of the motions of the bird's flight. Now, we know that the slight duration of the persistence of images on the retina necessitates a frequent

FIG. 5.—ENLARGEMENT OF ANOTHER IMAGE OF A BIRD TAKEN BY THE SAME APPARATUS.

repetition of the luminous apparitions in order to give our eye a continuous sensation.

I succeeded in constructing an apparatus having the dimensions of a sporting gun, which photographs twelve times per second the object sighted—each image requiring a time of exposure of 1-720th of a second (Fig. 1).

The barrel of this gun is a tube containing a photographic objective. At the back end of this, firmly affixed to the butt, there is a wide cylindrical breech piece, in which there is contained a clockwork, whose barrel is seen externally at B (Fig. 2, No. 1). When the trigger of the gun is pulled the wheelwork begins its movement and gives the various parts of the instrument the motion necessary. A central axis, making twelve revolutions per second, controls all the parts of the apparatus. First, there is an opaque metallic disk containing a narrow slit. This forms the cut-off or shutter, and allows the light emanating from the objective to enter only twelve times per second, and every time during 1-720th of a second. Behind this disk, and revolving freely on the same axis, there is another one which is provided with twelve openings, and behind this is placed the sensitized plate of circular or octagonal form (Fig. 2, No. 2). This disk must revolve in an intermittent manner, so as to

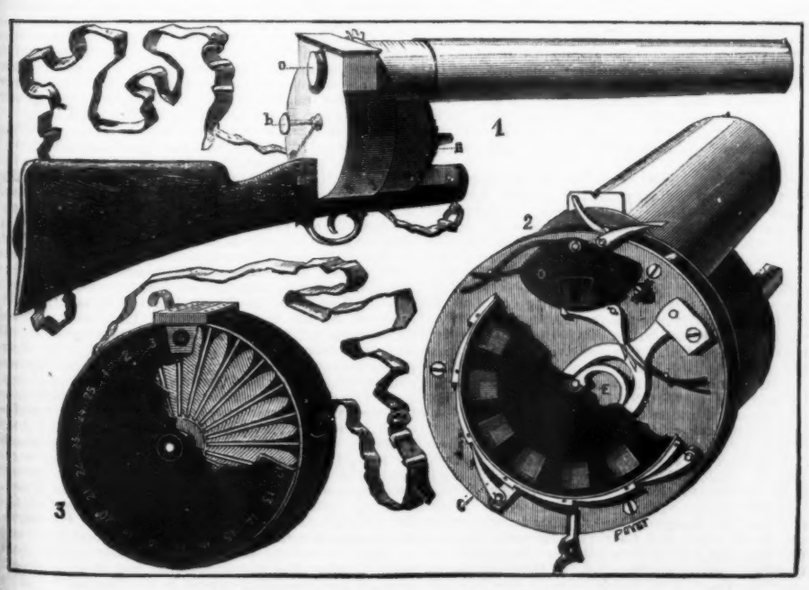


FIG. 2.—MECHANISM OF THE PHOTOGRAPHIC GUN.
1. General View of the Apparatus. 2. The Shutter and Perforated Disk. 3. Box containing 25 Sensitized Plates.

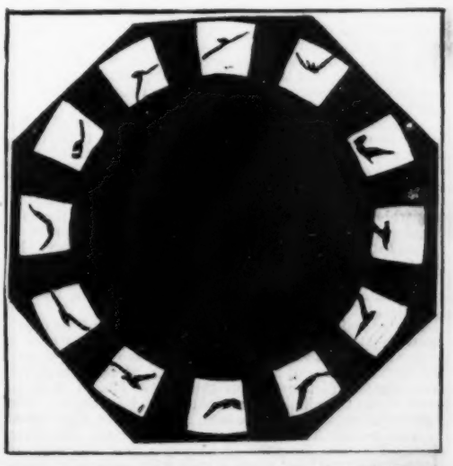


FIG. 3.—PHOTOGRAPH OF A GULL TAKEN DURING ITS FLIGHT.

stop twelve times per second opposite the fascicle of light that enters the instrument. This jerking motion is obtained by means of an eccentric, E, which, placed on the axis, gives a regular to and fro motion to a rod provided with a click, C, which, at every oscillation, engages with one of the teeth that, collectively, form a crown on the disk containing the apertures. A special shutter, O, cuts off all entrance of light into the instrument as soon as the twelve images have been obtained. There are other arrangements for the purpose of preventing the sensitized plate, owing to its acquired velocity, going beyond the position to which it is brought by the click, and at which it should be perfectly immovable during the duration of the luminous impression. A pressing button, *b* (Fig. 2, No. 1), rests firmly against the plate from the time that it is introduced into the apparatus; and it is through the influence of such pressure that the plate is made to adhere to the posterior surface of the disk containing the apertures. This surface is covered with black velvet to prevent slipping.

Focusing is effected by shortening or elongating the barrel, thus moving the objective backward or forward. The focus is finally verified by observing, through an aperture in the breech piece, the sharpness of the image received on a piece of ground glass. A box of circular form, such as shown in Fig. 2 (No. 3), serves for carrying twenty five sensitized plates, and for transferring them to the gun without their being exposed to the light.

Before applying this instrument to the study of flight, I submitted it to certain experimental proofs, and the results that I obtained were satisfactory. I arranged, for example, a black arrow upon a central axis, around which it revolved and detached itself from a white ground well lighted by the sun. The speed of rotation of the arrow was such that its extremities passed over about five meters per second, this representing six revolutions. Standing off at a distance of 10 meters, I sighted the center of the target, upon which nothing could be seen except a general slightly grayish tint, owing to the velocity of rotation. The sensitized plate, when developed, showed twelve images arranged circularly; and on each of these was observed the arrow, with the shadow it cast, as clearly as if it had been stationary.

Another time, I photographed a black pendulum oscillating in front of a white rule, which was marked off into divisions. The pendulum was beating seconds, and I obtained, in fact, twelve images, representing the successive positions occupied by the pendulum at the different phases of one complete oscillation.

For the sake of greater accuracy in the measurement of durations, I have adapted to the gun a chronographic apparatus, formed of an air capsule, which receives a shock at each displacement of the sensitized plate. This capsule is connected by a rubber tube with the inscribing apparatus, which makes a tracing upon a cylinder revolving at the same time as a chronograph or tuning fork of a known number of vibrations. In this manner the duration of the luminous impression, and the interval of time which separates the images from each other, are measured with a satisfactory precision.

After these experimental trials I began the photographing of animals in motion. In Fig. 3 is shown the photograph of a gull taken during flight, and which allows of the comparison of the twelve successive attitudes during the duration of a second. This flight is an irregular one, and exhibits alternations of hovering, and of a motion like that of rowing. In other experiments, I have succeeded in photographing the gull while flying sideways. As the bird was flapping its wings exactly three times per second, there are found in the twelve figures four successive attitudes, which are reproduced periodically. The wings are first raised to the maximum, and then they begin to fall. In the following image they are at the lowest point of their travel, and in the fourth they are rising again.

By enlarging these figures we obtain images visible at a distance, but the sharpness of which leaves much to be desired; for my negatives are slightly grainy, a fact that I attribute to my slight experience with photographic processes. The reproduction of these images by the heliotype process gives only a black silhouette (Figs. 4 and 5.) It should not be believed, however, that a certain amount of detail can never be obtained in the images; for I have placed under a microscope of low power negatives obtained with a very accurate focusing, and, on the images, which were those of a bird seen from above, I could easily count the wing feathers, and perceive their overlapping.

If the photographs of birds are arranged on a phenakisticope, the appearance of the motions of flight is well reproduced, but the images corresponding to each flap of the wing are still too few to lend themselves very well to an analysis of such motions. It becomes necessary, then, to increase the number. This may be effected by, for instance, doubling the velocity of the motion of the shutters and plate, as I have been able to do with this same gun, while having still enough light for the production of the images. The duration of the lighting of the plate was then only 1-1440th of a second; moreover, the objective employed was not of the quickest.

By photographing the bird under other conditions, such, for example, as when it is receding from sight or approaching or when it is seen from above or below, other data as to the mechanism of flight may be obtained. Thus, there may easily be observed the changes of inclination of the plane of the wing, the inflexion of the remiges on the resistance of the air, and the motions through which the body carries itself forward during the down stroke of the wing, and backward during the up stroke.

As regards this, I have already compared the data afforded by the photograph with those that the graphic method formerly gave me, and have thus obtained a confirmation of the principal points that I believed I had established by the former of these methods. There appears to be no doubt that photographic images will add much new knowledge to that which we already possessed with respect to the mechanism of flight. Before enunciating a decided opinion in regard to this, I shall wait till I collect the necessary elements, that is to say, a great number of images of birds of different species executing various kinds of flight, either in calm weather, or when the wind is blowing in various directions.

The bat is difficult to photograph on account of its capricious flight, its small size, and the late hour at which it makes its appearance. My best plates have given me only five or six images out of a dozen changes of position of the photographic plates; besides this, these images were in some cases at the limit of the field of the instrument. The rare experiments that I have been able to make with regard to this animal have shown, however, certain interesting facts. It is seen, from the photographs, that the angle of oscillation of the bats' wings is very wide, especially downward, where the two wings form two vertical planes that are perceptibly parallel. We find, moreover, that the bat can fly in spite of a removal of a considerable extent of the wing membranes, provided that the remaining portion corresponds to the interdigital spaces. Thus, among the images that I have taken there is one that is found several times; and this concerns a bat whose humerus and forearm appear to be entirely deprived of membranes, there being seen at the extremity of the wing only a sort of small fan formed of the interdigital membranes. The wing, thus mutilated, executed movements of greater extent than the one that was intact.

The photographic gun likewise assists in the study of the motion of different species of animals. I have photographed with it horses, asses, dogs, and men on foot or on velocipedes, but I have not followed such experiments up, as they enter into the programme that Mr. Muybridge has carried out with so much success. I propose especially to study by photography the mechanism of flight in different animals. It is already partially seen that to different forms of birds and insects there correspond differences in the manner of flying. Now, nothing appears to be more proper to cast a light on the mechanism of flight than this comparison of the function with the conformation of the organs in different species.—*E. J. Marey, in La Nature.*

MOUNTING AND BINDING TRANSPARENCIES, LANTERN SLIDES, ETC.

By JOHN HARMER.

As transparencies of various kinds seem to be again coming into fashion—or, at any rate, are occupying the attention of photographers, especially the amateurs—and as very little information has appeared of late years respecting their mounting and binding, perhaps a few remarks describing a once much practiced professional method will be acceptable to many.

Of all the operations connected with the mounting of photographs that of binding glass ones ranks A1 for tediousness, and, as performed by those who are unaccustomed to this class of work, is about as messy as could be desired; also, what with the squeiching of the mountant, combined with the resulting tendency of the paper binding to stick to anything that is rubbed down with in preference to the edge of the glass where it is wanted, one's patience is sorely tried, besides much labor in trimming and cleaning is necessary to make the slide neat and presentable when the paper has been induced to adhere somewhere near the place it is intended to remain. These troubles need not occur, for the exercise of ordinary care in putting the following instructions into practice will not only enable the photographer to avoid them, but will make the operation quite a pleasure instead.

The appliances and materials required are: A medium-sized "hog-tool" and an artist's quarter-inch round one in tin, a penknife, scissors, a few pressure weights of plate glass—having about a pound and a half of lead moulded or turned into a handle for convenience, and fastened on the upper side of each—and a porcelain glass slab of a size suitable for the work in hand; also a piece of velvet, some pieces of oil paper, or of thin and tough paper, such as foreign note, and a little powdered French chalk. The mountant should be strong gum water, prepared by dissolving a sufficient quantity of gum arabic in as little water as possible, which has been slightly acidulated with carbolic acid, and glycerine or treacle added in the proportions of ten drops to the pint. The former prevents putrefaction and the latter toughens the gum and prevents its cracking when dry. In very hot weather, without the addition of some such substance, the "edges" will not hold to the glass, but will spring off if touched. When dissolved the viscid liquid should be squeezed through fine muslin or washleather, and stored in a greasy-stoppered bottle for use. It will keep indefinitely.

If the two or more glasses comprising the slide cannot from any consideration be bound up with their surfaces in contact, nor a paper mat, if used, be interposed, one of the inner surfaces of the glasses must be provided with narrow strips of thick note paper or thin cardboard. These are rapidly prepared by brushing a thin layer of gum over the slab and laying several sets of the strips (previously cut to length) with slight pressure upon it without soiling their upper surface; then raise and place them in position on the transparency and cover with a pressure weight till a pile is completed. If there be nothing to prevent the mat being put between the glasses, as when the whole of the picture is upon one of them, the back of the mount may be touched with gum at two or three points to retain it in its place, and put under one of the weights to dry. Should it, however, be necessary to place the mounts outside, the gum must be more liberally spread, but not to such a degree that the "liberality" squeezes out, for nothing tends to sully the mount more than scraping and cleaning away messes of that kind. After drying under the weight any part of the mount projecting beyond the edges of the glass must be removed by placing the slide, face downward, on a cutting-glass or board, and trimming round with a sharp knife; any deficiency of mount is then to be made good in the latter instance. Whether the mat is between the glasses or on the surface makes no difference to binding up beyond the greater care necessary in handling, to prevent its being soiled with gum or hot fingers.

Now for the binding. The "edges" of the paper having been cut to the required width, by machine or knife, are then snipped into lengths—those for the shorter dimension of the slide a fraction less to allow for expansion when moist; those for the other half an inch or so longer than the side they are to bind. For many reasons it is better to put the short ones on first. These are, therefore, taken and placed between slightly-damped blotting paper while the slab is being prepared with a thin and even layer of gum, of which there should be just sufficient to make the paper hold when transferred to the glass without exuding when the pressure of rubbing down is applied. The black velvet having been spread flat upon the table, and a piece of the oiled paper placed over it, a slide is taken in the left hand, face toward the right, and one of the strips pulled from the slab. This is put gummed side up on the paper, and the edge of the slide brought into contact with it at the required distance from its edge, to which the slide is made parallel. It is then pressed downward into the velvet, whose pile is sufficiently hard to crease the binding and turn it up toward the glass on each side, besides keeping the two glasses square with one another. While it is held thus, the fingers of the right hand are passed underneath the oil paper, and their pressure exerted upon that part of the edging which is to adhere to the face of the glass; the slide is then turned face down at about the middle of the paper, the free half of which is drawn over its back, and the necessary pressure applied to the binding beneath. The slide is then raised in the paper for the finger and thumb to be passed along its edge once or twice to complete the operation; and here it is that the blessing of French chalk is appreciated, the fingers touched in the powder making all work smoothly. The opposite end of the slide having been served likewise, it should be reared up to dry, or till the whole of the batch is ready for the other pair of sides.

The longer "edges" are put on in a similar way to those above. A few modifications are necessary and advantageous when the slide is large or of awkward shape. Take, for instance, a stereoscopic one. The strips not having been trimmed to the exact length lest the extreme corners should be unprotected—arising from any slight variation in the length of any particular slide or in the extent of expansion the paper has suffered—are first gummed and then the end of the slide is placed flush with the further end of the binding, pressed into contact with the edge, raised, and the superfluous portion snipped off. It is then pressed upon the oil paper, the two sides of which are drawn tightly up to both sides of the glass, raised again and held in the hand while the rubbing down is effected with the finger and thumb. When the binding is finished and dry, it should be examined for any inequality in the width of edging at the back, and trimmed if necessary with a sharp knife and straight edge. The slide may then be cleaned and the finishing stroke of labeling given it.

In handling transparencies great care must be taken to avoid any pinching together of its component glasses, or very likely there will be some very nasty scratches to mend; and I have known, when wax deadening solutions have been used, whole patches to be transferred from one glass to the other.

In laying down each successive batch of the "edges" upon the slab be sure to carefully remove any bits of paper torn from the preceding, or grit and mess of any foreign description, and keep the layer of gum at the proper strength by dipping the point of the brush in water and working it into it. In summer time and during very dry weather it is absolutely necessary to moisten the strips previous to laying, or they will absorb the water so greedily that they will stick directly. If a batch exhibit this tendency it is a good plan to breathe upon them for a short time, pull and relay, and thus save expending much time in scraping or washing off the slab.

The kind of paper most suitable for binding is the bluish-black needle paper; it is close and tough in texture, with sufficient thickness to stand much wear without giving the slide a clumsy appearance. Any pattern in gold or bronze can be lithographed upon it without in any way affecting its good qualities.

The mounts or mats are best made of very thin and fine cardboard, strong enough to retain its shape when gummed, without being of such a thickness as to add to that of the slide. The apertures are best cut with dies which, if in proper condition, will make a clean one in tissue paper. Circles, however, may be cut with an expanding bit upon a piece of hard and close grained wood—but I am getting beyond the scope of my paper.—*Br. Jour. of Phot.*

HEAT OF ELECTRICAL SPARKS.

PROF. ANDREA NACCARI has re-examined the question of the unequal heating of the electrodes of a Holtz's induction machine by the passage of sparks. After carefully tabulating his results, he comes to the conclusion that in every case the negative electrode is less heated than the positive; that the heat developed in the spark is not affected by the nature of the metals of the electrodes; that with a constant striking distance between the ends of the electrodes the heating effect in each electrode is proportional to the quantity of electricity that passes in unit time; and that the quantity of heat thus developed by the passage of the electricity between the electrodes is very considerable.

A GELATINE EMULSION FOR DIRECT PRINTING.

UNTIL quite recently the application of gelatine emulsion has been confined almost entirely to negative work, except so far as its employment for enlarging purposes is concerned; at least, there has been no serious attempt to adapt it to direct printing on a small scale, and for the same class of work as that for which the collodio-chloride was used. Opal plates have certainly been an article of commerce in this country for some time; but the results were obtained by development, and possessed none of the richness of tone obtainable with collodio-chloride or albumen films, or even with developed collodion plates. During the last few months however, gelatino-chloride emulsion has gained a footing, owing mainly to the discovery of improved methods of development; and from accounts reaching us from all sides we learn that it is rapidly progressing in popular favor. Dr. Eder, Captain Abney, Mr. B. J. Edwards, and others have demonstrated how it is possible, by suitably modifying the exposure and development, to secure almost as great a range of tone as with albumenized paper; and for opal work, as well as for transparencies of all kinds, developed gelatino-chloride images appear to be admirably adapted.

For these purposes, however, the operation of development presents an objectionable feature—a slight degree of uncertainty as to the exact character of the tone that will be obtained. However carefully the exposure may be timed and the developer regulated, it is scarcely possible to insure a perfectly uniform class of results, and for this reason a method of direct printing has been a desideratum. Gelatine chloride plates may, it is true, be used for direct printing; but the tones obtained are unpleasing, and the general character of the image anything but satisfactory; while, as Captain Abney pointed out on Tuesday evening last, the chief difficulty lies in the fact that it is nearly entirely removed by the fixing solution. The same difficulties attended the early days of collodio-chloride emulsion. The images produced were thin and feeble, and, even if they presented any amount of vigor before fixing, that operation entirely removed it, leaving a weak, gray image of little pictorial value. By the use of a highly organic collodion matters were slightly improved; but it was not until the addition of citric acid or of an alkaline citrate was made to the emulsion, with an excess of silver nitrate, that anything like success was attained. The presence of a highly organic compound of silver was, in fact, found to be absolutely necessary for the production of vigor and richness of tone.

At the meeting of the Photographic Society of Great Britain, on the 9th of May, Captain Abney, in the course of his remarks on various methods of printing, and on the action of light on various compounds of silver, alluded to the marked effect that citrate of silver has of increasing the vigor of the impression caused by the direct action of light upon silver chloride in gelatine. The rough example

which were passed round showed in an unmistakable manner the value of this addition; for, not only is the image produced robust and vigorous, and capable of thoroughly withstanding the lowering action of the fixing bath, but it possesses a rich red color, somewhat resembling an untoned albumen print, which seems to promise the possibility of securing any desired tone by the application of suitable means. Indeed, Captain Abney informs us that these images lend themselves with facility to the production of any of the tones obtainable with albumenized paper, while the printing occupies but one-third of the time.

The emulsion is formed in the ordinary manner. An alkaline chloride and an alkaline citrate in proper proportions are dissolved in a solution of gelatine, and this is sensitized by the addition of silver nitrate. When a sufficient time has elapsed to admit of complete combination, the emulsion is washed and redissolved in the ordinary way, and is then ready for use either on glass or paper. It will be observed that, unlike collodio-chloride (or, as Captain Abney justly calls it, "collodio-citro-chloride"), there is no free silver present in any stage of the emulsion, and it may, therefore, be assumed that when dry the films will retain their properties unchanged for an indefinite period. In the presence of excess of silver nitrate we know that gelatine will sooner or later discolor spontaneously. The proportions of silver chloride and citrate mentioned by Captain Abney are about two of the former to one of the latter, though it is possible that these may be modified upon further trial. The films, before exposure to light, are extremely thin and opalescent, and certainly do not appear capable of giving the density of coloration which is obtained with them.—*Br. Jour. of Photo.*

TRANSFER PRINTING PROCESSES.

AN improved autographic transfer process for lithographic and zincographic printing has been developed by J. J. Magne, of Paris. The process consists in writing or drawing upon unprepared paper with inks or crayons having an affinity for fatty lithographic ink; then moistening the paper with a liquid having a repellent action for such ink; then inking up the writing or drawing with a lithographic roller, and finally transferring to the stone or zinc. The fatty lithographic ink is retained by the ink or crayon, but repelled by the liquid that moistens without attacking the cellulose of the paper, and the transfer is thus made without injury to the original manuscript, which may be preserved for an indefinite period. For the reproduction of printed matter by lithography or zincography, the same liquid is used, inasmuch as ordinary printing ink has the same properties as the inks of this invention. By moistening a printed paper with the liquid, and rolling up with lithographic ink, the typographic or other impression may without injury to the original be transferred to stone or zinc. The composition of the liquid is as follows: Water, 1,000 parts; acid (preferably sulphuric), 150 parts; alcohols (or their congeners), 350. These proportions may be varied, but it is essential that the proportion of alcohol should be high, in order to avoid injury to the original.

The formula above indicated gives good results; but it must be understood that the process is not limited to the employment of the precise ingredients herein mentioned, as this part of the invention consists essentially in the protective intervention of a substance (alcohols or other) in an acid liquid for the purpose of repelling the fatty ink. Under the term "acid liquid" are included not only acids properly so called, but also combinations of these acids with substances which, as they do not neutralize the acids, permit the combinations to act in the same manner as if the acids were pure. The patentee is thus enabled to use salts which, by reason of their acid nature, repel fatty ink; we may also add to the composition which fulfills the double purpose of preserving the paper and of repelling fatty ink, certain substances of a hygroscopic nature, which will retard the evaporation of the composition and keep the material impregnated therewith at a suitable degree of moisture. These substances may be briefly stated as being either of organic origin, such as gelatine rendered soluble, either hot or in the cold, soluble gluten, starch, dextrine, mucilages, gums, sugars, and glucosides, etc., or of inorganic compositions, such as deliquescent salts, etc.; and, in short, all substances capable of retarding the desiccation of materials impregnated with the composition. These substances may either be mixed directly with the composition, or they may be applied upon the originals to be reproduced either before or after impregnation with the composition.

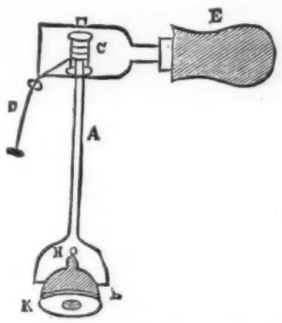
For the production of autographic transfers any kind of paper of medium thickness, sized or not, or other material may be used. The inks employed are composed of protein substances (albumens, caseins, fibrins, etc.), and of bichromates, prussiates, alums, etc, forming liquid compositions capable when dry of retaining fatty inks. The following is the method of preparation: Dissolve in a quantity of water two or three times greater than the quantity of albumen (or other protein substance) a mixture of two parts of bichromate, prussiate, or alum, etc., to one part of ferrocyanide of potassium, by which a limpid brown solution is obtained. Beat up separately a certain quantity of albumen and its equivalent of water. The proportion of the mixture of salts relatively to the albumen employed should be about six per cent. The two liquids are intimately mixed together with the addition of a suitable quantity of coloring matter. The ink thus made is unalterable, remains constantly fluid, and drawings or writings may be executed in it with a pen, brush or drawing pen upon any paper of medium thickness, avoiding cardboard and tissue paper.

The crayons to be employed for the same purpose are of paraffin or its congeners, and lampblack, bone-black, ivory-black, etc., or other impalpable coloring matter, so as to form crayons marking like those of black lead, red chalk, or charcoal. The proportions for lampblack crayons are about 100 parts of paraffin to 16 parts of lampblack, but may be varied according to the depth of color desired. To produce crayons of different degrees of hardness there should be melted with the paraffin before mixture with the coloring matter a certain quantity of common or other resin, regulated by experience, but which should not in most cases exceed 10 per cent. The melted mixture is run into moulds, and, after cooling, the crayons are cut into lengths and either inclosed in stiff paper or cased in wood in the manner of ordinary lead pencils. If the drawing has been executed with ink alone it may be used as soon as it is dry, but if executed with ink and crayon, or crayon only, the face of the drawing should be held for one or two seconds over a vessel containing boiling water. The paper is then allowed to dry by exposure to the air, more especially if the drawing be done both in ink and crayon, after which the paper is placed face upward in a bath of water, acid, and alcohol, as before specified, and allowed to remain until it is thoroughly saturated, which is known by a sort of exudation of the liquid through the pores. The paper is then carefully spread out upon a glass plate or on a board, and an inked lithographic roller passed over it, whereby all the lines of the drawing are coated with fatty ink. When sufficiently inked a damp sponge is passed over those parts of the paper which have retained any of the ink, taking care not to blur the drawing, which is then washed and placed to drain upon a slab of plaster, and when brought to the proper degree of humidity it is laid down upon the stone or zinc plate, and the transfer pulled in the ordinary way. In order to preserve the drawing in an unaltered condition it is necessary (1), to wash it with a solution of carbonate of ammonia or of soda filtered; (2) to rinse it in pure water; (3) to drain upon a plaster slab or blotting paper; (4) to dry it by strong pressure between blotting paper.

The process of reproducing printed matter is as follows: The mixture of alcohols and sulphuric acid, before referred to, is applied with a brush either upon the front or back of the printed matter to be reproduced. The paper becomes instantly saturated with the liquid, and the surface is then immediately washed by applying or plunging in pure water. The sheet is then spread very carefully upon a glass plate or board previously wetted, and a lithographic ink roller passed over the print, taking care if the roller is passed more than once over the print to moisten the surface of the latter with pure or slightly acidulated water to prevent the paper adhering to the roller. If this operation, which is very simple, has been performed by a skilled hand, it is only necessary to lightly wash the print to remove the excess of acid, which would otherwise bite the stone too deeply, then to drain upon a slab of plaster, and when brought to . proper degree of humidity, to lay it down upon the stone and pull it through. The transfer is then complete, and the ordinary lithographic process proceeded with in the usual way. When it is desired to reproduce both sides of a sheet, one side is inked and transferred first, and then the other side is inked and transferred. For the reproduction of typographic printing the transfer would be made upon a polished zinc plate, and then bitten in with acid in the ordinary way.

INSTRUMENT FOR COATING PHOTO PLATES.

M. FISCH presented lately to the French Photo Society a very ingenious instrument for covering copper or zinc plates with an even coating of bitumen or albumen. The plate to be coated is fixed to the apparatus by turning the screw, H, which raises the India-rubber, K, and causes a vacuum. The solution is poured upon the plate, and the apparatus held as in the following diagram. The string is pulled



A, Iron bar, to which is attached the pneumatic sucker, B. C, a bobbin made of wood, round which the string, D, is wound. E, handle to hold the instrument.

sharply on the beginning only, the rotary motion obtained continuing and winding up the string again, and so on as long as it is required. The idea is borrowed from a child's toy which amused our early years. I remember well a kind of windmill upon the same principle.

M. Gobert showed the members a very curious result which he had obtained by experimenting upon a new mode of obtaining a gelatino-bromide emulsion. He mixed a bromide with gelatine and allowed it to set. Upon this jelly he poured a solution containing the equivalent of silver nitrate. After a prolonged contact he found that the emulsification, or, more properly speaking, formation of the silver bromide was only superficial. Upon analysis he found that the water contained no silver, and that the gelatine contained no bromide. Upon washing the crust of silver bromide and drying it, it became very hard, emitting a metallic sound, and was useless for photographic purposes. The experiment is only interesting as a chemical reaction by dialysis.

M. Garnier made some very interesting experiments upon his process, which he names "athmography"—a new and strange chemical reaction which the inventor did not fully explain. I can therefore only describe what I saw, and make a few remarks thereon. M. Garnier took a copper plate upon which a photographic image (positive) was formed—I am not aware by what process. This plate was laid for about three seconds, face downward, upon two supports about one inch high. These supports were fixed upon the bottom of a wooden box; the interior of the box, or, properly speaking, the bottom of the box, was smeared over with hydrofluoric acid. After being exposed to the vapors of this acid for about three seconds, as aforesaid, the plate was laid upon a glass previously coated with a composition consisting (as well as I could learn) of borate of soda and sugar. The copper plate was firmly pressed for one instant only upon this composition, and then taken and covered over with a fine powder by the aid of a camel's-hair brush, in the same way as the image is formed for enamels by the dusting-on process. Thirty or forty proofs can thus be printed per minute. According to the powder employed any color can be obtained. If metallic oxides be used the glass can be placed in a furnace, and an unalterable picture be formed. In fact, the enamel process, although now so expensive and beautiful, will soon become as cheap as positives upon paper. It was wonderful to see the ease and rapidity of production. A new road is now about to be opened for photographic productions. They will, ere long, be "a joy for ever," and not a fleeting image of the past.—*E. Stebbing, Prof., in Br. Jour. of Photo.*

GELATINO-CHLORIDE OF SILVER PICTURES BY DEVELOPMENT.*

By B. J. EDWARDS.

FROM the earliest days of photography, chloride of silver has been most largely used in the production of photographs; but hitherto very little has been done in developing the latent image formed by the action of light on chloride of silver films. The idea is not, however, a new one. I have brought for your inspection some fine transparencies developed on collodio-chloride by Mr. H. J. Newton, President of the Photographic Section of the American Institute, New York. These beautiful pictures were presented to me in America, in the year 1872—just ten years ago. Since that time others have experimented in the same direction. Mr. Herbert B. Berkeley has from time to time published the result of his researches; and, more recently, Dr Eder and Captain Pizzighelli have given details of their method of producing diapositives on emulsion plates containing chloride of silver in combination with gelatine. The same gentlemen have also shown at Vienna, and at the recent technical exhibition in this building, a series of beautiful transparencies which were universally admired. As these pictures seem to have awakened considerable interest in the process by which they were produced, I propose (this evening) to demonstrate the method of producing transparencies on gelatino-chloride plates, and to describe certain modifications in the development which I have found to give the best results.

For the preparation of the emulsion, the following simple formula is all that is required:

Gelatine	300 grains.
Cold water	4 ounces.
Nitrate of silver	240 grains.
Distilled water	2 ounces.
Chloride of ammonium	100 grains.
Water	4 ounces.

Mix the above in three separate vessels, allow the gelatine to soak for ten minutes, and warm all the solutions to about 120° F. Now add the silver to the gelatine, and immediately afterward add the chloride. Emulsify at the same temperature for about an hour; then allow the emulsion to set. Pass through canvas and wash in running water for some hours in the usual way. When washed and dissolved by gentle heat the emulsion will be ready for coating the plates. The glass chosen should be as thin and flat as possible, to insure contact in printing from the negative. The dried film should appear pure white by reflected light, and of an orange tint by transmitted light. The latter color is owing to the chloride of silver being held in an extremely fine state of division.

With regard to the sensitiveness of these plates, I have found them at least a hundred times less sensitive than ordinary gelatino-bromide plates. The time of exposure will depend, to a great extent, upon the color desired in the transparency and the strength of the developer. With a moderately strong developer an exposure of two or three seconds to diffused light under an ordinary negative will give all the detail.

The developer I use is a modification of Dr. Eder's formula, and that of Captain Abney. A stock solution is made as follows:

Citric acid	5 ounces.
Distilled water	20 "
Strong ammonia	2 "

The heat produced by the addition of the ammonia will cause the crystals of citric acid rapidly to dissolve. As soon as the mixture is sufficiently cooled the solution is ready, and will keep a long time. When required for use, mix three parts of the above solution with one part of the ordinary ferrous oxalate developer, freshly made, by adding one part of a saturated solution of sulphate of iron to three parts of a saturated solution of neutral oxalate of potash. Now add to each ounce of the mixture two or three drops of a twenty-grain solution of bromide of potassium.

This will form a very powerful developer for the gelatino-chloride plates, and, with a moderately short exposure, will give a rich purple tone to the transparency. For a pure black tone, expose less time, and use equal parts of the ferrous oxalate and citrate of ammonia solutions, with an extra drop or two of restrainer, if required. If much warmer tones are desired, six or eight parts of the citrate solution should be used to one part of the ferrous oxalate. Any shade of color may be obtained, from jet black to bright ruby red; but, with the weaker developer, it will be necessary to increase the exposure considerably. For instance, to obtain the ruby color, two or three times the exposure will be required than for the black tones with the stronger developer. In this way a great variety of beautiful tones may be produced at will; but the great advantage of this method of development consists in the very great latitude allowed in the exposure. When working by daylight, and with negatives of different degrees of density, it is practically impossible to be sure of getting the correct exposure except by repeated trials, unless the developer can be regulated to suit the exposure given. By my method this is easily done. I make three or more portions of developer of different degrees of energy—that is, containing a greater or less proportion of the ferrous oxalate. Should the transparency appear underexposed, the developer is at once poured off, and the development completed, and all the details brought out with a more energetic solution. In the case of over-exposure the operations are reversed. This power of correcting under or over exposure in the development of pictures on chloride of silver has not hitherto been obtained by any known method; and I think I may venture to assert that without the power of compensating for errors in exposure, the process of printing by development on chloride of silver, however beautiful in some of its results, would be practically useless. With regard to the keeping qualities of the developer, I find that after being mixed it gradually but slowly loses its energy, otherwise keeping in perfect condition for several weeks. It can, however, at any time be restored to any desired strength by adding the proper proportion of freshly-made ferrous oxalate developer, as in the first instance.

With regard to the utility of this really beautiful process, I think few will question its superiority for the production of the most exquisite transparencies for lantern slides, or for making enlarged negatives. There is, however, another application of the process which may eventually prove of far greater importance. I allude to the rapid production of silver prints on paper by development, instead of the present slow process of printing out under the negative. I

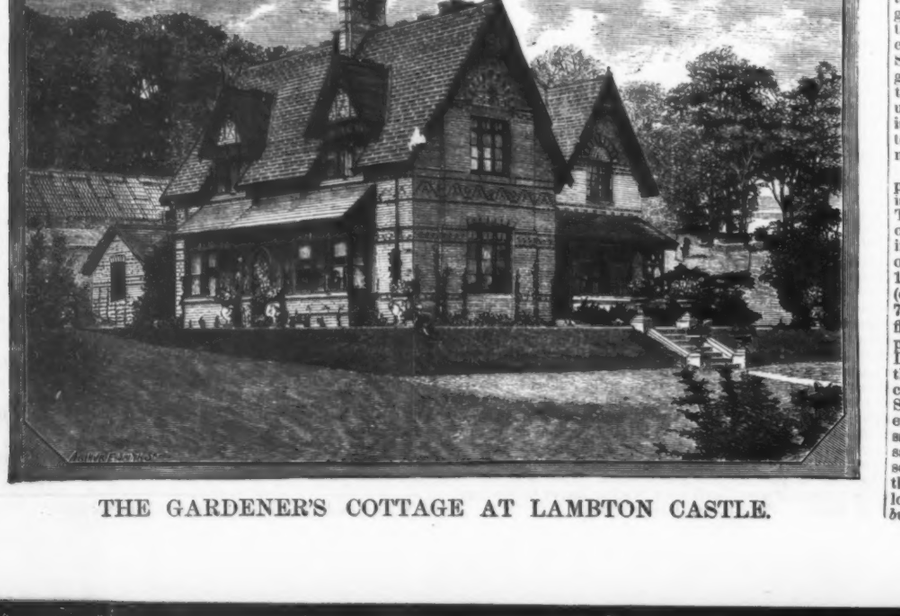
* Read before the South London Photographic Society.

have already made a few experiments in this direction, and, from the results I have already obtained, I should judge that it is not improbable that the process I have described to you to-night will prove in time the quick printing process of the future.

GARDENERS' COTTAGES.

IF, during the present generation, there had been such general improvement in the habitations in which gardeners and their assistants are housed as there has been in the structures in which are grown the plants they cultivate, many of the craft would be better off in this respect than they at present are. This, of course, refers to the matter generally, not exceptionally, for, to the credit of many who own large gardens, there has been a marked improvement in recent times, not alone in gardeners' houses, but also in the places where the young men are lodged. Among such there are few places where more thoughtful consideration has been given to the wants and comforts of all engaged in and about the garden than there has been at Lambton Castle, as will be seen from the views we here give of Mr. Hunter's house, and also that in which the young men live. Both are really handsome buildings, possessing every convenience, with plenty of room in them. In the young men's house there is a dining-room, reading-room, and bath-room, and a separate bedroom for each man. Neither are the garden laborers forgotten in the matter of their dwellings. Within five minutes' walk of the garden there are half a dozen pretty, commodious cottages that have not only an air of comfort about them, but their external appearance is such as to induce the occupants to take a pride in keeping them nice.—*Gardeners' Chronicle.*

THE "BOTHY" AT LAMBTON CASTLE, DURHAM.



THE GARDENER'S COTTAGE AT LAMBTON CASTLE.

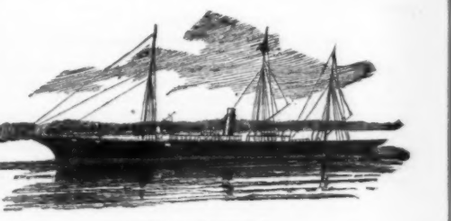
THE HIGHEST BUILDING IN EUROPE.

HITHERTO the hospice of the Great Saint Bernard, which stands 8,200 feet above the level of the sea, has enjoyed the distinction of being the most elevated inhabited building in Europe. This honor it can no longer claim. During the past year the city authorities of Catania, in Sicily, have caused to be erected, near the summit of the great volcano, Mount Etna, an astronomical observatory, which stands 2,948 meters above the sea-level, or fully 1,000 feet higher than the hospice of Saint Bernard. The structure is nine meters in height, and covers an area of 200 square meters. It consists of an upper and a lower story, and is built in a circular form. In the lower story there rises a massive pillar, upon which is placed the great refracting telescope. The lower story is divided into a dining room, kitchen, and store-rooms. In the upper story there are three bed-rooms, intended for the accommodation of astronomists and tourists visiting the establishment. The roof consists of a movable cupola or dome. From the balconies of the upper story a prospect of vast extent and grandeur is presented. The spectator is able to see over half the island of Sicily, the island of Malta, the Lipari Isles, and the province of Calabria, on the mainland of Italy. The observatory is erected upon a small cone, which will, in the case of eruption, protect it completely from the lava stream which always flows down on the opposite side of the volcano.—*Builder.*

JAMES GORDON BENNETT'S NEW YACHT.

THE interior decorations of the Namouna are such as have never before been seen on a vessel—not even the Czar's Livadia. The best artists that this country possesses in this line were employed, and the effect produced is such as but few if any palaces or private residences on shore can rival. The woodwork of the various divisions is all of the richest, and each is of a different kind from the other. That in the ladies' cabin is of mahogany, that in the main saloon of English oak, and Mr. Bennett's private apartments in cherry. The ceilings are all elaborately frescoed, and the bed on which the owner is to repose cost $1,000 alone. The Edison electric light illuminates every part, the successful application of that light on the steamers of the Oregon Railway and Navigation Company having demonstrated its superiority.

The engines were built by Ward, Stanton & Co., of Newburg, N. Y., and are of 400 horse power; high pressure cylinders, 22 inches in diameter; low pressure, 42 inches; stroke of piston, 28 inches. The boilers are two in number—shells 13 feet in diameter, 11 feet long, 120 square feet grate surface and 3,000 square feet of heating surface. Two pairs of valves manufactured by the Consolidated Safety Valve Company, of New York, and known as the Nickel Seated "Pop" Safety Valve, have been placed on the boilers. These valves are 4½ inches in diameter, and adjusted to allow a working pressure of 80 pounds to the square inch. The bearing surface is made of solid nickel castings, which prevent corroding or sticking fast in the seat. They are spring loaded, and will open and close on a variation of only



THE NAMOUNA.

two pounds pressure, and all the working parts are arranged with a lock-up device, which prevents any possible tampering with the valves. The steam gauges, clocks, revolution counters, and engine indicators for the engine and fire rooms are all of the most approved patterns, having been furnished by the Ashcroft Manufacturing Company of Boston. These important appliances are all in elegant silver-plated cases, the dials being of the same material and elegantly engraved.

THE NEW WELLAND CANAL.

THE enlarged Welland Canal is now open for traffic, and for the past few days the hearts of our citizens have been gladdened by the upward and downward movement of vessels through this channel—a channel destined when fully completed to revolutionize the carrying trade of the lakes. In 1821 the agitation for the construction of a canal to connect Lakes Erie and Ontario was begun, which culminated in 1823 by a committee of the Legislature reporting in favor of its construction, the canal to be of such dimensions as would accommodate the class of vessels then navigating the lakes. In 1824 the Welland Canal Company was organized. Through the unflagging efforts of the late Hon. W. H. Merritt public meetings were called, and every possible means taken to excite public opinion in favor of the work, but only a small measure of success attended the efforts, for at the ceremony of turning the first sod on November 30, 1824, only about half a dozen persons were present. Mr. Merritt, however, persevered, and finally succeeded in building the canal, notwithstanding the fact that the history of his company was one of financial embarrassment. The locks of this canal were of wood, 110 feet in length by 22 feet in breadth, the prism of the channel being 26 feet at the bottom and 58 feet at the surface of the water. It was five years from the date of breaking ground before vessels ascended from Lake Ontario to the Welland River, and thence through the channel to Lake Erie. In 1833 the work was completed to Port Colborne. In 1839, the Government decided to acquire the work, but it was not fully carried out until 1841. After the canal became the property of the Government it was enlarged and the locks constructed of stone. In 1870 the necessity for a still further enlargement could no longer be delayed. After thorough investigation it was decided not to enlarge the old channel but to build an entirely new canal from Port Dalhousie to Allanburg, there to join the old channel, which was to be deepened and improved to meet the enlarged scale of navigation. In 1871 it was decided to go on with the work, and in 1872 tenders were asked for portions of the work. All the contracts are now complete except the aqueduct at Welland and the rock-cutting at Stone Bridge. The non-completion of the aqueduct is a great drawback to the working of the canal, inasmuch as the scale of navigation contemplated cannot be obtained until the new structure is completed. However, the canal is open, and it now remains for the people of Canada to demonstrate to the world that they have not spent their money in vain.

The propeller John C. Gault, of the Wabash Line, which passed down the enlarged Welland Canal on Saturday last, is the largest propeller which has yet gone down to this date. The Gault has a length of hull over all of 233 feet, breadth of beam over all of 33 feet, and depth of hold 13 feet 6 inches. Her capacity is 31,000 bushels of corn on a draught of 11 feet 6 inches of water, and 42,000 bushels of corn on 13 feet 6 inches. Her cylinders are 24 and 54 inches bore (compound), with 3 feet stroke. She has two steel boilers 7 feet in diameter and 16 feet long, single furnaces, and five flues, and a steam pressure of 102 pounds. The time occupied in going through the new cut from Thorold to Port Dalhousie was twelve hours, and sixteen hours in going through the entire canal. Not the slightest hitch or difficulty occurred in the trip through the canal, and Captain Stewart expressed himself well satisfied with his first experience in navigating the enlarged Welland Canal. It is very satisfactory to know that the navigation is found to be satisfactory. Many of the gates work stiffly as yet, and some of the lock-tenders are rather green at the work. But this will soon be remedied by experience and use. The lockages are made in about twenty minutes.—*Chicago Tribune.*

THE THEORY OF THE GAS-ENGINE.

AT a recent meeting of the Institution of Civil Engineers, a paper on this subject, of which the following is an abstract, was read by Mr. Dugald Clerk.

The author said that the practical problem of the conversion of heat into mechanical work had been partially solved by the steam-engine; but its efficiency was so low that it could not be considered as complete or final. Hot air in the past had been looked upon as a possible advance; owing, however, to many futile attempts, it had long been deemed useless to look in this direction for better results. The great progress made in recent years with the gas-engine—from the state of an interesting but troublesome toy to a practical, powerful rival of the steam-engine—had shown that air might, after all, be the chief motive power of the future.

Three distinct types of gas-engines had been proposed:

(1.) An engine drawing into the cylinder gas and air at atmospheric pressure for a portion of its stroke, cutting off communication with the outer atmosphere, and immediately igniting the mixture; the piston being pushed forward by the pressure of the ignited gases during the remainder of its stroke. The instroke discharged the products of combustion.

(2.) An engine in which a mixture of gas and air was drawn into a pump, and was discharged by the return stroke into a reservoir in a state of compression. From the reservoir the mixture entered a cylinder, being ignited as it entered—and without rise in pressure, but simply increased in volume—and following the piston as it moved forward, the return stroke discharged the products of combustion.

(3.) An engine in which a mixture of gas and air was compressed, or introduced under compression, into a cylinder or space at the end of a cylinder, and then ignited while the volume remained constant and the pressure rose. Under this pressure the piston moved forward and the return stroke discharged the exhaust.

Types 1 and 3 were explosion engines, the volume of the mixture remaining constant while the pressure increased. Type 2 was a gradual combustion engine, in which the pressure was constant but the volume increased. Calculating the power to be obtained from each of these methods (supposing no loss of heat to the cylinder), it was found that an engine of Type 1, using 100 heat units, would convert 21 units into mechanical work; in Type 2, 36 units; and in Type 3, 45 units. The great advantage of compression was clearly seen by the simple operation of compressing before heating; the last engine giving, for the same expenditure of heat, 2·1 times as much work as the first. In any gas-engine compressing before ignition, igniting at constant volume, and expanding to the same volume as before ignition, the possible duty, D, was determined by the atmospheric absolute temperature, T¹, and the absolute temperature after compression, T; and it was $D = \frac{T-T^1}{T}$, whatever might be the maximum temperature after ignition. Increasing the temperature of ignition increased the power of the engine, but did not cause the conversion of a greater portion of heat into work. That was, the possible duty of the engine was determined solely by the amount of compression before ignition. Compression made it possible to obtain from heated air a great amount of work with but a small movement of piston, the smaller volume giving greater pressures, and thus rendering the power developed more mechanically available. Seeing the great difference produced between Types 1 and 3 by the simple difference in the cycle operation when there was no loss of heat through the sides of the cylinder, the question arose which engine in actual practice, with the cylinder kept cold by water, would come nearest this theory. In which of the engines would there be the smaller loss of heat? Comparing the two engines with equal movements of piston, it was found that the compression engine had the advantage of a lower average temperature, and a greater amount of work done; also of less surface exposed to flame, and consequently it lost less heat to the cylinder. Taking all the circumstances into consideration, it was certainly not over-estimating the advantage of the compression engine to say that it would, under practical conditions, give for a certain amount of heat three times the work it was possible to get from an engine using no compression.

It was interesting to calculate the amounts of gas required by the three types under the supposed conditions. Taking the amount of heat evolved by one cubic foot of average coal gas as equivalent to 505,000 foot-pounds, and calculating the gas required if all the heat were converted into work, it was found to be 3·92 cubic feet per horse power per hour. Therefore, the amounts of gas required by the three types of engines would be—

Type 1. $\frac{3·92}{0·21}$ = 18·3 cubic ft. per horse power per hour.

" 2. $\frac{3·92}{0·36}$ = 10·9 " " "

" 3. $\frac{3·92}{0·45}$ = 8·6 " " "

Comparing these figures with results obtained in practice from the three types of engine losing heat through the sides of the cylinder, it was ascertained that the amount of gas consumed was as follows:

Type 1.	Lenoir . .	95	cubic ft.	per indicated horse power p. h.
	Hugon . .	85	"	"	"
" 2.	Brayton,	50	"	"	"
" 3.	Otto	20	"	"	"

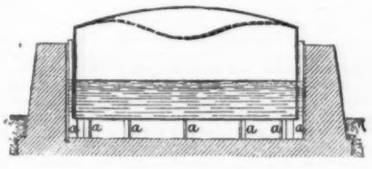
It would be seen that the order of consumption was what was required by theory. The Otto engine converted about 18 per cent of the heat used by it into work, while the Hugon engine only converted 3·9 per cent. Taking the loss of heat to the cylinder as given by the comparison of the adiabatic line of fall of temperature with the actual line of fall as shown on the indicator diagram, it appeared much less than was really the case, as shown by the gas consumed by the engine. The maximum pressure produced was much less than would be expected from the amount of gas present; and this was due to the limiting effect of chemical dissociation. The gas-engine presented a more complicated problem than a hot-air engine using air heated to the same degree. Analyzing the disposal of 100 heat-units by Clerk's gas-engine, it was found to convert 17·8 into work; to discharge 29·3 with the exhaust gases; and to lose through the sides of cylinder and piston, 52·9 units. About one-half of the whole heat used passed through the cylinder and heating water. Ste. Claire Deville had shown that water was decomposed into its constituents at a comparatively low temperature, considerable decomposition taking place at 1,200° C. The cause of so near an approach to the line of theoretical fall, as was shown by the actual indicator diagram, was simply the continuous combination of the dissociated gases. At a maximum temperature of about 1,600° C., complete combination of the gases with oxygen was impossible, and could only take place when the temperature fell low enough.

In calculating the efficiency of the gas-engine from its diagram, all previous observers had fallen into error, through neglecting the effects of dissociation, and, accordingly, their results were much too high. To account for this so-called sustained pressure, Mr. Otto had advanced the theory that inflammation was not complete when the maximum pressure was attained at the beginning of the stroke; but that by a peculiar arrangement of strata he had made it gradual, and continued the spread of the flame while the piston moved forward. Mr. Otto called it slow combustion. This designation seemed to the author to be erroneous; as such an action should rather be called slow inflammation. It existed in the Otto engine, but only when it was working badly, and was attended with great loss of heat and power. This was proved by a diagram, and by certain considerations deduced from Bunsen and Mallard's experiments on the rates of propagation of flame through combustible mixtures. The conclusion arrived at was that slow inflammation was to be avoided in the gas-engine, and that every effort should be made to secure complete inflammation at the beginning of the stroke. The author said he had found it possible to ignite a whole mass in any given time, between the limits of 0·1 and 0·01 of a second, by arranging the plan of ignition so that some mechanical disturbance by the entering flame was permitted. A diagram taken from the Otto and Langen free-piston engine—as given in a paper by Mr. F. W. Crossley, and an analysis of his reasoning—showed that the results were misinterpreted, and false conclusions arrived at concerning the nature of an explosion. Mr. Crossley considered that an explosion of gas and air, pure and simple, must be accompanied by a rapid rise and an almost instantaneous fall of pressure. This, he thought, was proved by the diagram, but in this statement the author could not concur.

From the considerations advanced in this paper, it would be seen that the cause of the comparative efficiency of the modern gas-engines over the old Lenoir and Hugon type was to be summed up in the one word "compression." Without compression before ignition an engine could not be produced giving power economically and with small bulk. The mixture used might be diluted, air might be introduced in front of gas and air, or an elaborate system of stratification might be adopted; but without compression no good effect would be produced. The gas-engine was as yet in its infancy, and many long years of work were necessary before it could rank with the steam-engine in capacity for all manner of uses. The time would come when factories, railways, and ships would be driven by gas-engines as efficient as any steam-engine, and much safer and more economical of fuel. The steam-engine converted so small an amount of the heat used by it into work, that, although it was the glory and the honor of the first half of this century, it should be a standing reproach to engineers and scientists of the present time, having constantly before them the researches of Mayer and Joule.

FAILURE OF A GASHOLDER.

LAST summer the roof of a large gasholder at Prague was forced in by the pressure of the atmosphere, a partial vacuum having established itself in the interior. The circumstances of the case will be understood from the following description from *Engineering*. There are four gas works at Prague, three of them are municipal, whereas the fourth (established in 1845) is private property. Until recently these last works were situated amidst a populous suburb (Karlin); lately, however, they had to be removed completely out of town. At the new works, which the company was obliged to erect beyond the boundaries of the suburb, two large gasholders were built last summer. One of these gasholders having been completed, its interior was cleared of the staging and water was filled in. During this process the gasholder was supported by narrow pieces of wood (*a a*, see the annexed figure).



When the water had reached a certain height above the lower edge of the gasholder, it was resolved to remove the supports, *a a*, and to let the gasholder down. Accordingly all openings and manholes were hermetically closed, and an attempt was made to take out the wooden supports, *a a*. This attempt, however, failed, and the gasholder was left standing as it was. This had occurred on a very hot morning. In the afternoon of the same day a heavy rain fell, and the temperature suddenly dropped by several degrees. In consequence, the air in the interior of the gasholder was cooled down, a partial vacuum was formed, and the roof of the gasholder was suddenly forced in with a heavy crash, assuming the form shown by the dotted line in the figure. The removal of the distorted roof and the erection of a new one, constituted, of course, a heavy loss to the company. Happily there were no workmen on the roof at that time, so that no lives were lost.

A NEW SPINNING MACHINE FOR WOOL.

THE inventions of the present day may be classed under two heads: those which are intended to improve the details of existing machines, or parts of machines, and those which either produce new machines or apply to existing ones new principles, and thus, so to speak, convert them into entirely new machines. Our present illustrations represent arrangements belonging to the latter class, and are intended to accomplish the twisting and spinning of the woolen thread in a manner which until now has not been applied to it. The invention comes to us from Switzerland, being brought out by M. Arnold Munzinger, of Olten, and on that account deserves perhaps more than a passing notice, for, though the Swiss spinners and machine makers are more occupied with cotton than with wool, they will only follow the example of England by trying to transfer to the spinning of wool some of the machinery and appliances used in cotton spinning.

The machine in question is what in cotton spinning is called a throstle and in wool spinning a continuous spinning frame. The spindles are ranged on either side of the frame,

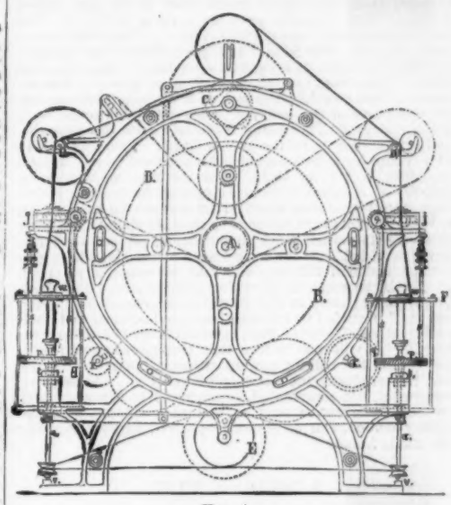


FIG. 1.

and are driven by bands, from an underlying tin roller, in the usual way. Here, however, the similarity with other machines used for spinning wool ceases, and we pass on to its peculiar features, which to a cotton spinner will be at

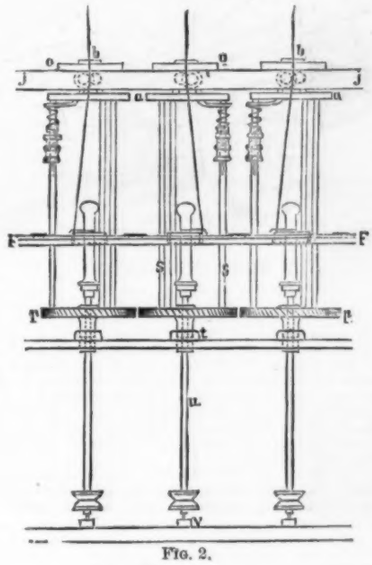


FIG. 2.

once clear when we say that it is a coiler employed for twisting the yarn in the last process. Fig. 1 shows a vertical section through the machine at right angles to the spindle rail. Figs. 2 and 3 are some of the details of the

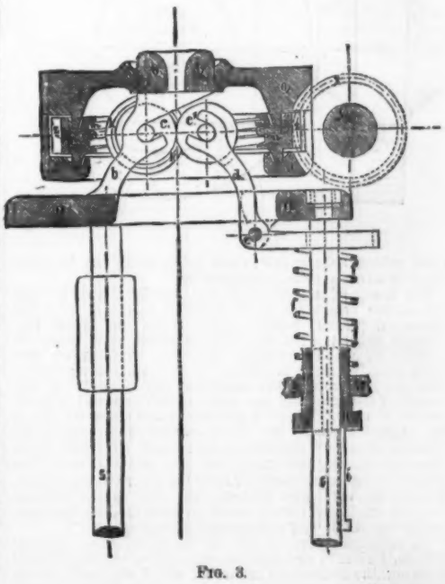


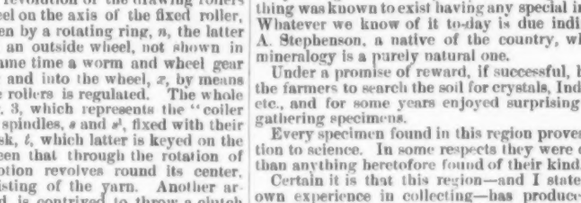
FIG. 3.

machine. Though all these illustrations represent a ring frame, we understand that the inventor does not confine himself to this mode of winding-on, but applies his improvements equally to flier frames. The roving is placed

horizontal bobbins in the upper part of the machine, and thence passes between guide rollers, D, into a funnel, J. Just below this funnel a pair of horizontal rollers exactly like those in a coiler receive the sliver between them, and through their accelerated speed draw it to any desired fineness. This is shown more particularly in Fig. 3. The two drawing rollers are marked *c* and c^1. They rest in two arms, *b* and *d*. The former of these is fixed to the bracket, *a*, while the latter is hinged at *e*, so that it may draw its roller further from *c*, or approach it more closely. The adhesion of the two drawing rollers is accomplished through the lower arm of the lever, *d*, being pressed upward by a spiral spring, *f*. This spring fits loosely upon the spindle, *s*, and is tightened up by the nuts, *g* and *h*. This substitution of a spring for a dead weight, which is used in all English machines, is a point about which perhaps much may be said by our spinners. The revolution of the drawing rollers is produced by a level wheel on the axis of the fixed roller, *c*, which is in its turn driven by a rotating ring, *n*, the latter receiving its motion from an outside wheel, not shown in our illustration. At the same time a worm and wheel gear into the inside of this ring and into the wheel, *x*, by means of which the speed of the rollers is regulated. The whole arrangement shown in Fig. 3, which represents the "coiler motion," is carried by two spindles, *s* and s^1, fixed with their lower extremities into a disk, *t*, which latter is keyed on the spindle. It will thus be seen that through the rotation of the spindle the coiling motion revolves round its center, and this produces the twisting of the yarn. Another arrangement, not represented, is contrived to throw a clutch on the spindle out of gear, so that each spindle, or rather coiling motion, can be stopped by itself, without stopping the whole frame.

A MEXICAN CART.

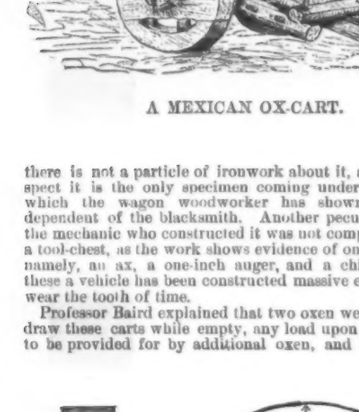
THIS primitive vehicle, as shown, is well worth a close study, as it points to some remarkable facts which will strike the most careless observer. The first of these is, that



A MEXICAN OX-CART.

there is not a particle of ironwork about it, and in this respect it is the only specimen coming under my notice in which the wagon woodworker has shown himself independent of the blacksmith. Another peculiarity is, that the mechanic who constructed it was not compelled to have a tool-chest, as the work shows evidence of only three tools, namely, an ax, a one-inch auger, and a chisel; but with these a vehicle has been constructed massive enough to outwear the tooth of time.

Professor Baird explained that two oxen were required to draw these carts while empty, any load upon them having to be provided for by additional oxen, and the music of



these rolling spheres (no grease being used) can be heard miles in advance of their appearance.

The trunk of a large-sized tree has been used in each wheel, the central or nave portion, together with the segmental pieces, being hacked from the solid log. Though at first sight these wheels strike us as being extremely rude and barbarous, still, upon examination, they show great ingenuity in design, for by the manner in which they are constructed the mechanic has secured the full benefit of the arch, and has made a durable wheel without the aid of a tire. This of itself constitutes a novelty, for in the countries where iron tires are not used, rawhide or wooden withes are substituted, and nearly all wheels, from whatever country they may come, are designed upon this idea of being bound together from the outer circumference. But the mechanic who designed the ones shown, whether he were originally Toltec, Aztec, or more modern Mexican, struck out boldly and constructed an original wheel.

To more fully give an idea of the massiveness of these wheels, I give, in two sectional cuts following the principal drawing, the dimensions in inches; and I also add dimensions of other parts of the cart, which are as follow: Length of center-piece or pole, 15 ft.; size of ditto, 5 x 7 in.; length of side-pieces, 6 ft. 4 in., size of ditto, 4½ x 6 in.; width across bolsters, 3 ft. 4 in.; length of axle, over all, 6 ft.—*The Hub.*

THE DISCOVERY OF EMERALDS IN NORTH CAROLINA.*

By WM. EARL HIDDEN.

THAT emeralds have been found in the United States has been doubted. The press has stated "the discovery of emeralds needed confirmation." It is my pleasure to show you this evening convincing proof of the existence in our country of this rare and beautiful gem. Since what the impetus was that started the search for emeralds in North Carolina would be of interest, I will give you the story, gathered as it is from a year's residence on the spot where the discovery was made.

Sixteen years ago, the site of the North Carolina emerald mine was covered with a dense primitive forest. Less than ten years ago the locality was mineralogically a blank; nothing was known to exist having any special interest or value. Whatever we know of it to-day is due indirectly to Mr. J. A. Stephenson, a native of the country, whose interest in mineralogy is a purely natural one.

Under a promise of reward, if successful, he had engaged the farmers to search the soil for crystals, Indian stone relics, etc., and for some years enjoyed surprising success in thus gathering specimens.

Every specimen found in this region proves to be a revelation to science. In some respects they were of more interest than anything heretofore found of their kind.

Certain it is that this region—and I state this from my own experience in collecting—has produced some of the most remarkable and beautiful specimens of emerald, spodumene, beryl, rutile, and monazite, thus far discovered in the United States.

To be brief and to the point, I will say, that in a few localities in Alexander county, crystals would be brought of the common opaque beryl; but now and then a semi-transparent prism, having a decided grass-green color, much resembling the famous crystals from Siberia, so familiar to mineralogists, would be found and offered for sale in the neighboring towns. Those came to have the name among the farmers of "green rocks" and "green bolts." From the fact of their selling for more than anything else they found, these green crystals became the ultimatum of their searching.

Among other curious local names for minerals were "donicks" for quartz crystals; "black bolts" for prisms of tourmaline; "red metal" for rutile crystals, and "needle rock" for the beautiful sagenite, or arrows-of-love stone.

Suffice it to say that in a period of about six years, there were found loose in the surface soil, on three plantations in this county, a small number of beryls having a color verging distinctly upon the true emerald tint, none of which crystals, however, were deep-colored or transparent enough for use as gems.

Some of these crystals were obtained by the Mr. Stephenson before mentioned. It was the sight of two of these "green bolts" which prompted me to visit the locality and make a search for the true emerald. I cannot understand why work was not commenced long ago, when such favorable signs were so common.

That such indications could receive only passing notice from collectors is really inexplicable. A very natural conclusion would have been that where these pale emeralds were found loose in the soil, darker and purer ones would be found by mining for them.

Such inducements as the following were held out to the farmers to search for these "green bolts:" A visiting collector had offered the munificent sum of *one dollar* to farmers who should find a crystal as long as his finger, which must, to merit the dollar, be *dark-green*, pure, transparent, and with perfect terminal planes and prismatic faces!

Such is the history of the emeralds found in Alexander county before I commenced systematic mining for them.

The location of the mine was obtained in the following manner: A corps of workmen was employed to dig a series of deep ditches in directions that would cut the strata at different angles. The site chosen for work was on the spot where at least half a dozen pale emeralds had been found. This location was shown to me by the farmer who had discovered the specimens while plowing.

Not knowing then their manner of occurrence, I expected in this way to strike a vein bearing them. Five weeks were spent (in July and August, 1880) before any success was met with; and then, at a depth of eight feet, was discovered a "blind vein" (so called because it had no outcrop), having very small emeralds. In this vein, or pocket, as it proved to be later, and outnumbering the emeralds fifty to one, was also found the new emerald-green mineral which was such a surprise to the scientific world, and which was destined to answer the same purposes as did the gem I sought. I refer to the spodumene-emerald, now known as hiddenite.

You must pardon this digression, but the search for emeralds is so interwoven with my discovery of emerald-green spodumene that I cannot tell the story of one without the other. The two minerals occur intimately associated, and, while mining for the one, the other is constantly found.

This blind vein yielded very handsomely of the new mineral, but very sparingly of emeralds, and the few found were too small to be useful as gems, though their color was very good. A tunnel, for the purpose of drainage, 261 feet long, mostly through rock, was cut to this vein, and a shaft sunk down upon it. At this time the work on this vein has reached a depth of thirty-six feet, at which point it proved its pocket nature by pinching out—closing together.

Thus far, twelve of these pockets have been found within an area of forty feet square, carrying emeralds, four of which pockets contained also the spodumene-emerald.

All these veins maintained nearly the same character of dip, thickness, length, and associations.

Other pockets were found that yielded quartz, rutile, monazite and mica crystals of great beauty. Others yet, whose walls were covered with finely crystallized dolomite, calcite, apatite (transparent and pellucid), rutile, pyrite, quartz, and mica.

In one instance, a small pocket that contained two beautiful emerald crystals, had its walls covered with large crystals of albite (twinned parallel to the basal plane). Another pocket contained only mica crystals and one small pellucid, colorless beryl, that had both ends brilliantly terminated with many planes. I mention the above associations that you may learn the diversity in these pockets, although they are so near together.

In the rock-mining, and while prospecting on the surface, the sign of a vein is the presence of small streaks of massive quartz, or of mica, in a counter direction to the strike of the country-rock, either of which lead to open pockets not many feet off. The gems have thus far been found loosely attached to the rock. Not over nine emeralds have been found at any one time. Mineralogists have a great treat in store for them when deep rock-mining is accomplished here. Then the gems will be found firmly attached, and they will shine with all their primitive crystalline beauty.

The largest emerald found in this mine is eight and a half inches long, and weighs nearly nine ounces. It was one of nine fine crystals contained in a single pocket; their color was excellent, and they were transparent, though somewhat flawed.

The locality is situated about thirty-five miles, air-line measure, S. E. from the "Blue Ridge" Mountains. The *contour* of the country is low rolling, and its altitude is about 1,200 feet. The soils are chiefly red, gravelly clays, of not much fertility. The prevailing rock is gneiss, with more of a feldspathic than a micaceous character; the trend of the strata is N. N. W. and S. S. E., with a dip nearly vertical.

The gems and crystals occur in open pockets (miniature caves), of very limited extent; these are cross fractures or fissures in the rock. These fissures, lenticular in shape, are usually nearly perpendicular.

There being no glacial drift here, the soils are necessarily the result of decomposition and disintegration on the spot. It is therefore an easy task to find the source of minerals found on the surface. The "*frost-drift*" theory of Prof. Kerr is everywhere proven in this region. He well says that "to a foreign geologist entering the South Atlantic States for the first time, a hundred miles or more from the coast, the most striking and novel feature of the geology is the great depth of earth that everywhere *mantles and conceals the rocks*. This is readily discovered to be, for the most part, merely the result of the decomposition *in situ* of the exposed edges of the underlying strata. The vertical and highly-inclined bedding-lines of strata *are distinctly traceable by the eye, through this superficial earth-covering, and are seen to pass by insensible gradations into the undecayed rock beneath.*" At this locality, the unaltered rock is found at a depth of twenty-six feet, and is of unusual hardness, especially where it walls the gem-bearing pockets.

Thus far the gems have been found in a narrow belt running N. E. and S. W., and scattered over a distance of three miles. In this belt, signs of cross-fissures are very abundant, and it is a very common thing to find crystals of quartz, rutile, tourmaline, etc., etc., *perfectly preserved*, scattered over the surface.

A peculiar feature pertains to most of the emeralds and beryls from this region. They appear as though filled across the prismatic faces. The basal plane is also often pitted with minute depressed hexagonal pyramids, that lie with their edges parallel to one another, and to the edge of the di-hexagonal prism. Rarely, though, crystals are found with perfectly smooth and brilliant faces. The emerald color is often focused on the surface, and fades gradually to a colorless central core, which feature is of exceeding interest when the genesis of the mineral is considered. The emeralds have been found of richer color, and less flawed, as the mine gets deeper. [These points were illustrated by a beautiful series of specimens.]

In regard to the commercial value of the emeralds thus far found, I will frankly state that the majority of the crystals have little value for gem purposes; but as cabinet specimens they are unprecedented, and as such have a market value ranging from $25 to $1,000 each.

From the largest crystals, stones of over one carat weight could be cut that would be marketable as gems; but as scientific specimens, the crystals in their entirety would have greater value. Certainly no better signs could be wished for than these specimens to prove the existence at this locality of dark-colored crystals, pure enough for cutting into valuable gems.

This region has a great future as a gem-producing district. Mining skill and capital are the only essentials needed to insure success. It may be interesting to note that the entire expense of the work at this locality has been more than repaid by the sales of the gems (hiddenites) discovered. But for the liberal financial aid given to the writer by both Mr. Richard H. Roberts, of Albany, and Mr. James D. Yerrington, of Cresskill, N. J., the work of discovery and development at this locality would have been very much retarded, if not indefinitely postponed.

DISCUSSION.

Dr. Newberry remarked on the extreme beauty of the specimens exhibited by Mr. Hidden, and the great interest of these discoveries, in which he had achieved such signal success, both practical and scientific.

Dr. R. P. Stevens made some further remarks on the communication, comparing the aspect of the specimens, and the mode of their occurrence, with those of the emeralds from the celebrated locality near Bogota. He referred to the fact, also, that the Bogota mines had been worked by the early aborigines, and were doubtless the source of the emeralds described with so much enthusiasm by the Spanish historians of the conquest of Peru.

* A paper read before the New York Academy of Sciences, January 30, 1882.

A NEW MANGANESE MINERAL.

By MALVERN W. ILES.

THE mineral very closely resembles fauserite, which is a sulphate of manganese and magnesium.

The mineral has a bitter, astringent taste. It is very readily soluble even in cold water. The aqueous solution effervesces with sodium carbonate, and reddens blue litmus paper. Ammonium sulphocyanide does not give a test for sesquioxide of iron. Upon boiling the water solution, a very slight iron precipitate is formed.

It is found in Hull Valley, Park county, Colorado, upon the McDonnell mining property. This 'claim' is near Middle Swan Creek, and 13 miles from Webster, situated on the Denver and Rio Grande R. R. The vein is located above timber line, the apex of location being in frozen snow. The gangue is over 300 feet wide, and shows upon the rocks this efflorescent salt. There is said to be a trace of gold and silver contained in the gangue for the above-mentioned entire distance. The gangue after being freed from the soluble mineral gave by fire assay at the office of the Grant Smelting Co., 9 oz. silver per ton (2,000 lb.). In some places there is a pure streak of this mineral of two to eight inches in width.

DISPERSION LIQUIDS.—The author has shown the power of dispersion presented by combining in a parallelopipedon two prisms having very different indices for red and violet light, and equal indices for light of mean refrangibility. He finds that among the liquids which furnish at once a sufficiently powerful dispersion, a perfect transparency, and the total reflection of the red and the violet part, benzol and benzylene, combined with quartz, eliminate the extreme red, while pure anethol eliminates the extreme violet.—*C. V. Zenger.*

EDISON'S ELECTRIC RAILWAY.

THE bed of Edison's Electric Railway at Menlo Park is as yet unballasted, so that a ride over its two miles of length is productive of unpleasant jerks and bumps. From the building next to the workshop at Menlo Park, where the steam engine and dynamo-electric machines are placed, a narrow plank walk leads across the field toward the woods in the rear. In this are the wires running from the dynamo-electric machines to the railway track, distant perhaps a quarter of a mile. Here the wires are noticeable, emerging from their casing and communicating with the rails. At first sight the track appears to differ from an ordinary railroad only in its gauge, which is three feet six inches. But a closer examination reveals three distinctive features. Where two rails meet they are joined together on the sides. On each side of the joint is a strip of copper, the ends of which are nickel-plated. Outside, these strips are screwed on flat bars of iron, the inner surface being also nickel plated. Thus the current of electricity passes uninterruptedly from rail to rail. As this cannot be done at the switches, however, thin plates of copper are placed underneath the ends of both rails, so that the circuit is not broken. The frog in the switches is left out of circuit. It is only about three feet long, and as the driving-wheel of the engine is 4½ feet in diameter the wheel passes over the frog with no perceptible interruption. Near the improvised engine house, which stands a short distance above the point where the wires connect with the rails, and about a quarter of a mile from that end of the track, the one passenger car of the railway stood. The engine was running up and down the track, conveying Charles T. Hughes, the superintendent, and dragging a small platform car loaded with rails and ties. In appearance the engine is peculiar. If an ordinary engine was cut in two midway of the boiler, the forward half discarded, and the cab reduced in size, it would present a tolerably correct representation of the electric engine. Its length is 15 feet, and the height to the top of the cab nine feet. Of course there is no smoke-stack.

When a reporter took a seat in the cab the flat car had been left at the lower end of the track. Mr. Hughes raised the lever of the armature switch and the engine started. The engine ran evenly at the rate of 18 miles an hour. No arrangement had been made for running at high speed, as Mr. Hughes was using the engine simply in construction work, and it had been dragging loads of three or four tons. The four dynamo-electric machines at the central station were arranged in a multiple arc instead of in series, as is done to attain a higher speed. Two miles of the road have been completed, extending toward Plainfield, and a mile remains to be finished. At the lower end men were engaged in ballasting the track. The road runs from the engine-house over a trestle about twelve feet high, through a swamp, and then through some fields, where there are cuts. Thus far the engine has done all that was expected. Yesterday and on several previous occasions it has proved itself equal to the task of drawing loads as heavy as could be applied, considering the character of the road and rolling stock. On Wednesday, with the dynamo-electric machines arranged in series, it ran at the rate of 41 miles and 4,000 feet in an hour, the highest rate that has as yet been reached. The rate of speed is estimated by the number of revolutions of the armature in the engine. The engine can be readily started, reversed, and stopped. In the cab, where the steam gauge is placed in the ordinary engine, is the armature switch. Raising the lever sends the current into the armature of the dynamo-electric machine in the front of the engine. If the lever is horizontal the circuit is broken, and if the lever is pulled down the current is directed into the armature in such a way as to cause it to revolve in the opposite direction, and the engine consequently moves backward. Mr. Edison intends to use an electric brake, but at present in order to stop the circuit is broken and an ordinary brake applied.

In examining the engine more closely the reporter found two sheet-iron doors in the sides of what appeared to be the boiler, so that an inspection of the interior was easy. In front is a dynamo-electric machine; running lengthwise are the two legs of a large magnet, and the remainder of the interior is occupied with shafts and belting. An interesting feature is the course of the current and its transformation into motive power. It is taken up from the rails by the rims of the driving-wheels, and passes through copper clamps to the hub. Rubbing against the hub is a copper brush at the end of a horizontal rod, which has the position of the connecting-rod of an ordinary engine. The current taken from the hubs of the driving-wheels by these brushes passes along the rods to wires which lead to the armature switch in the cab. From this switch the two wires are conducted to the armature of the dynamo-electric machine in front. This machine may be said to fulfill a double function—in absorbing and storing up electric energy as well as in developing it. When the armature and bobbins revolve the power is transmitted by belting around a pulley on the same shaft with the armature to a pulley on a shaft under the cab. Thence belting runs to a pulley on the shaft of the driving wheel. From the armature wires two smaller wires run to the coils of the magnet placed horizontally in the engine. These are the field wires, and through them the magnet becomes charged with electricity, and exerts a controlling influence on the armature which receives the greater force of the current. Without this magnet the armature would receive the full power of the current and would become so heated as to be useless; but the electricity in the magnet, which can be increased or diminished at will, tends to draw the armature toward it, and in reality causes it to revolve.

The total weight of the engine is four tons. The road, three miles long, will soon be completed and ballasted. The chief merits which Mr. Edison claims in favor of his electric motor are greater economy in fuel, in help, and in the wear and tear of material, and the absence of smoke and cinders. One central station for every ten miles of track is his estimate, the current being sent through the rails for five miles on each side of the station. After elaborate calculations in the case of the electric motor as compared with the steam locomotive engine, Mr. Edison claims that the ratio of mean economy for both is 4 to 8·93, or 55¾ per cent. in favor of the electric engine.—*New York Tribune.*

ELECTRIC RESISTANCE OF SELENIUM.

PROF. MANFREDO BELLATI and Dr. R. ROMANESE have investigated the rapidity with which light modifies the electric resistance of selenium. The question has a practical bearing upon the construction of the photophone, since, if the time required to produce this change were considerable, the most rapidly vibrating sounds would become confused or inaudible in transmitting them. When light falling on a selenium cell was interrupted 1,250 times per second, the resistance was practically the same as with a far less rapid interruption giving equal average illumination. All the experiments of these gentlemen led to the result that selenium behaves sensibly, as if the variation of resistance by the incidence of light were effected instantaneously.

THE SECONDARY BATTERY.

To charge the electrodes of a secondary battery to their maximum potential requires a quantity of electricity roughly proportional to their surface. But if the source from whence the charge is derived is of an electromotive force inferior to this maximum, then the polarization charge is limited, not by the surface of the electrodes merely, but by the fact that the opposing polarization completely stops the current. M. Blondlot has lately determined the quantities of charge required to polarize to such a limit a voltameter of given electrodes, when the electromotive forces are also of given magnitude. This was done by using a voltameter with very small electrodes, and including in the circuit with it a battery, a ballistic galvanometer, and an apparatus for closing circuit during a determinate fraction of a second. By the device of increasing the area of one or other of the electrodes, M. Blondlot was able to study independently the two cases of polarization by oxygen and of polarization by hydrogen. The author further shows (*Journal de Physique*) that the elementary capacity of an electrode for a given electromotive force does not depend on the nature of the electrode. The latter is also proved by a single qualitative experiment. It follows that to charge, by an instantaneous polarization, the electromotive force between an electrode and electrolyte of value e_1 to a value e_2, the same quantity of electricity is always required, whatever the chemical nature of the electrolyte. Further, the charge of the double electric layer at the surface of contact of an electrode and electrolyte does not depend on the nature of the electrolyte if the electric difference remains the same. M. Blondlot has also given an absolute measure of the initial capacity of platinum in water acidulated by sulphuric acid, and shows that this capacity may vary under different influences.

A NEW ELECTRIC GAS LIGHTER.

THE General Electric Apparatus Company, of 33 Aldermanbury, have brought out an electric gas lighter, the invention of Messrs. Clarke & Leigh, of Manchester, for which many advantages are claimed. An ebonite handle, divisible into two parts, contains a battery and coil, both of which are specially improved for the particular purpose of the arrangement. The former is a chloride of silver cell; the salt being compressed instead of fused, as usual. The advantage of this battery is that it does not waste by local action when the circuit is broken; and the practically complete absorption of hydrogen in the brief and intermittent working permits of the whole being hermetically sealed up. The cell contains a charge sufficient to last for at least 25,000 ignitions; and when exhausted it is easily replenished, at slight cost, with fresh chlorides. In connection with the battery is an induction coil with make-and-break action, and provided with an exterior button, which, upon being pressed, makes an automatic temporary contact, sufficient to pass a spark for lighting one gas burner. The spark is produced between two metallic points, resting on a piece of terra-cotta, at the end of a brass rod of any convenient length or shape which may be required for the purpose of lighting burners in different situations. The special advantages of this arrangement are claimed to be its neat and solid construction, offering little risk of getting out of order, and the simplicity and sound scientific combination of parts and materials in the battery and induction coil. It shares with other electrical lighters in the qualifications of cleanliness and perfect security from fire, while it is claimed to be pre-eminently economical, practically inexhaustible, and not liable to give trouble.

EXPERIMENTS IN UNDERGROUND TELEPHONY.

AN underground cable has recently been laid along the Boston and Providence Railroad by the American Bell Telephone Company, for the purpose of ascertaining, by actual experiment, what may and what may not be done in telephony upon underground wires. The fact that the American Bell Company has gone to so much expense in connection with such experiments shows that it is in earnest, and, that if underground work shall prove practicable, it will not be neglected.

The cable was made by Eugene F. Phillips, of Providence, R. I., and consists of twenty-one rubber covered copper wires in an external protecting pipe of lead. Ten of these conducting wires, after being insulated with rubber, are covered with tin foil, which is intended to act as a conducting surface to carry off extraneous induction currents. Ten more, after being covered with rubber, are twisted together, and are intended to be operated as metallic circuits. This plan is also regarded as a protection against induction.

The twenty-first wire is an ordinary No. 13 office wire, covered with cotton and paraffined. The cable when completed weighed 30 tons, and filled three freight cars. It was laid on Sunday, April 16, between the two tracks of the Boston and Providence Railroad, the south end being at Attleboro, Mass., and the north end at West Mansfield.

The entire length of the cable was about a hundred feet over 5 miles. It was divided into sections of 530 feet in length, each section coiled on a separate reel.

A trench varying from 8 to 12 inches in depth was made, in which the cable was buried, the two ends of each adjoining section being connected by screw connections in test boxes, placed at the required positions.

Not the least interesting feature in the operation was the method adopted of excavating the trench. A box car attached to a locomotive was provided, which was made open at the rear end and carried the necessary tools. A beam of wood was lashed to the rear of the car. To this a plow was chained, a man took hold of the handles, and the locomotive was started, the plow cutting the trench at the rate of three miles an hour.

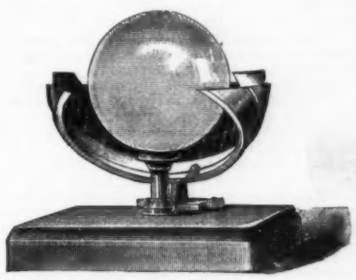
The cable was then laid in a similar way from the reels, which alternately were placed at the rear of the car, and when the last length was deposited in its earthy bed, the same inventive talent which had devised the locomotive plow drawer devised also a method for filling up the trench. A heavy plank was trailed from the car at such an angle that when the train moved ahead the earth and gravel were scraped back into the trench and the cable properly covered. Several lengths of the cable being uncompleted, the work could not be finished until the following Sunday, April 23.

Roadmaster E. M. Merrill, of the Boston and Providence Railroad; Messrs. Phillips & Sawyer, the manufacturers, and Mr. H. B. Lyttle, the manager of the Boston Telephone Dispatch Company, were present, the latter gentleman having had the entire charge of the mechanical details of laying the cable. The upper room at Attleboro station is to be the testing room, and it is expected that valuable knowledge will be gained by the proposed experiments, which will be conducted by the electricians of the American Bell Telephone Company.

It is interesting to note in this connection that while those engaged in this enterprise were totally unaware that the use of a plow propelled by a locomotive had ever been previously suggested for the purpose of making a cable trench, such an arrangement was patented in 1850 in England by Dr. Werner Siemens, who claims separately both plow and locomotive. There is certainly nothing new under the sun.

HOW TO MEASURE THE SUNSHINE.

ABOUT thirty years ago, Mr. Campbell, of Kensington, fitted a ball of glass into a wooden bowl, the adjustment being so made as to insure the coincidence of the heat focus of the solar rays with the surface of the wood, so that whenever the instrument is exposed to sunshine of sufficient intensity the great luminary leaves its trace in the shape of a charred mark on the internal surface of the wooden bowl. This somewhat crude apparatus was found to yield most valuable results, as the depth to which the wood was burned or charred indicated approximately the intensity of the solar radiations. Professor Stokes has recently pointed out that it is not by any means necessary to sacrifice a whole wooden bowl for each experiment, and that a highly satisfactory result can be obtained by using a strip of card mounted on a kind of half-round gallery placed as shown by the subjoined woodcut. Another improvement is the



SUNSHINE MARKER.

accurate graduation of the cards into hours and half-hours; and in order to render the same cards available at all seasons, the frame is so marked off that the position of the printed card can be varied according to the time of year. In this form the apparatus is a sun-dial of no mean value, it being often easy to tell the time by it within ten minutes, and all calculations are rendered unnecessary, owing to the facilities provided for the accurate adjustment of the cards.

Not only does the "sunshine recorder" in its present convenient form register sunshine, but the extent to which the card is charred indicates in a very striking manner the intensity of this sunshine; it being most curious to note how the course of the sun is sometimes marked by a fine line only just visible when the card is carefully placed in relation to the light, and at others by a thorough charring of the card throughout its entire thickness. The photographer knows very well that the thermic energy of the sun's rays does not correspond exactly with their actinic activity; but, notwithstanding this, valuable information may be obtained by an inspection of the card when an exposure is about to be made.

The improved form of sunshine recorder as now referred to is in use at most of the meteorological stations throughout the country, and the indications obtained with it seem likely to show that intimate relations exist between sunshine and health on the one hand and sunshine and fertility of the soil on the other hand. We understand that Mr. R. J. Lecky, of Lorton Terrace, Ladbroke Road, W., who is agent for the apparatus, will shortly be in a position to publish important information bearing on these points.

It should be mentioned that an extremely feeble sunshine does not, as might be expected, visibly affect the card; but on a moderately bright day it will record considerably over 90 per cent. of the sunshine; and if the cards were charged with a very small proportion of slightly sensitive chloride of silver, it is probable that even the extremely feeble sunshine might also be recorded.—*Photo. News.*

THE EFFECTS OF HEAT AND COLD ON ICE.

To the Editor of the Scientific American:

It has been estimated that Minnesota contains between 7 000 and 10,000 lakes. The beautiful natural scenery of the State is greatly enhanced by these sparkling gems dotting its surface. The greater part of them are filled with pure water clear as crystal. Around the shore of most of them is a ridge, or embankment of sand, gravel, and sometimes bowlders, running parallel with the water-line, and often ten to fifteen feet higher than the low adjacent land. These "walls" or "embankments" have caused a good deal of speculation as to their origin. Some have supposed that they were made by a prehistoric people for roadways, while others think the beavers have constructed them. But careful attention will soon convince any one that these ridges are caused by the expansion of ice, which freezes fast to the sand, gravel, and stones at the shore, and the expansion causes the ice to crowd outward, carrying whatever is frozen to it up on to the shore.

Nine-tenths of the educated people suppose that ice expands during cold weather; but such is not the fact. Ice, when once formed, is subject to the same law as other solid bodies—is expanded by heat and contracted by cold. The terms heat and cold are used relatively. For the last fifteen years of my residence on the shores of Pearl Lake I have been a close observer of the effects of heat and cold upon ice, having taken many daily observations and measurements of the ice and temperature during that time. Pearl Lake is one mile and a half long by one mile and a quarter wide, and is quite shallow near the shore. On the north, east, and west sides, the ice freezes firmly to the sides and bottom; but on the south side there are innumerable springs where the water oozes up through the gravelly bottom, which prevents the ice from freezing to the sides and bottom wherever they occur. Whenever the ice expands it will

be in the direction of the least resistance; hence the movement of the ice in this lake is to the south.

In the forepart of last December I placed one end of a long pole against a tree on the low bank, the other end resting on the ice, where I made a mark. The temperature was 20° above zero in the morning, and rose to 40° by three o'clock P.M. during the day. The ice had moved toward the shore twelve inches. For several days the mercury indicated from 26° to 28° above zero in the morning, and rose to 35° or 40° during the day, and the ice would move out from six to eight inches, and at night would contract or draw back about one-fourth as much as it had expanded. Some mornings the thermometer stood below zero, and would run up to 15° or 20° above; still there would be the same outward movement. The same movement occurs, only to a less extent, when the mercury rises from 25° below zero to zero. These observations have clearly established the fact that the ice expands or moves outward when the thermometer is rising, and contracts or draws back when the temperature is growing colder. There is no outward movement of the ice on the north shore. There are a number of places on the south side where there are no springs, and the ice carries up in its frigid grasp the sand and gravel of the shallow bottom and sides, and piles them ten to fifteen feet high; and when the ice melts in the spring, the *debris* form a ridge, or adds to the height and width of one already formed, which are often 200 feet wide at the base—plainly showing that this work has been going on for ages. During the expansion of the ice, it cracks in thousands of places in all directions. When the weather turns colder, each separate piece of ice contracts, and the cracks open, the water rushes up and fills them and freezes, thus forming new ice to replace that which was left on the shore. Some scientists contend that the expansion of the ice is caused by the addition of new ice on the under side of that already formed. Actual observations refute that idea. Last winter the ice remained twenty inches thick for weeks, during which time there was a large outward movement of the ice every day. I made two and three daily observations nearly every day during December and January, and part of February. While the ice is expanding or contracting, there is a continuous cracking of the ice, the sound of which is almost deafening, and can be heard a mile or more.

The ice has averaged about twenty feet thick, and is so clear that fish can be seen in the water below. The cracks can be easily traced in the clear ice—some will be from top to bottom, others from the top part way through; while a few appear to begin at the bottom and come nearly to the top. This peculiar phenomenon is accounted for in this manner: The ice rests upon water which always remains at about the same temperature, 32° above zero. If the weather above is colder, the top of the ice contracts the most, forming cracks, which are widest at the top in the shape of a V. These fill with water and freeze. When the temperature rises above 32°, the top of the ice is expanded more than the bottom, which forces cracks in the bottom in the shape of the letter A, which fill with water and freeze. Thus, at every change of temperature, there are additions of new ice to replace that which has been crowded out on the shore. During this winter the total outward movement has been about forty feet over and above the contractions.

The movement of the ice last winter was more active than usual, for there was no snow to protect it from the weather. Snow is such a good non-conductor, that a covering of eight or ten inches will prevent any movement, and the ice will lie still all winter.

The breaking of a pitcher or other frail vessel, when water is frozen in it, is not caused by the expansion of the ice. The water freezes on the outer sides, first forming an unyielding and hermetically tight case around the water. The water thus inclosed is gradually frozen, and each particle or crystal of ice, as it is formed and forced into the confined water, takes up more room than the water did of which it is composed. It is like forcing hard substances into a barrel full of water until the pressure is great enough to burst the barrel. If there was a small hole kept open for the escape of the compress water, there would be no harm done to freeze water in the most fragile vessel.

E. H. ATWOOD.

Maine Prairie, Stearns Co., Minn., May 9, 1882.

ON THE PRECIPITATION OF TANNIC ACID AS TANNATE OF COPPER.*

As a supplement to my method of tannic acid determination, I have prepared this paper, which is a part summary of the results found while investigating the accuracy of the method. A tannate of copper was prepared from two sources, and examined in the manner noted below, not to demonstrate the hypothetical constitution, or to argue upon the much disputed subject, but merely to demonstrate the complete precipitation of the tannic acid from the decoction before the second titration, and to show its purity. I hope, however, that some chemist may investigate upon the hypothetical tannates, and by original research, and make known to us some of the compositions of this compound. If I had leisure at this time, I would investigate them myself, but as I am situated now this is impossible; however, I will attend to it in time. In reading up all that has been published upon tannic acids, I have become, as others, convinced that there is a wide field for research among the tannic acids and their tannates (that is, if there be more than one tannic acid, which I very much doubt). Summaries of results of the investigations of chemists upon this subject are innumerable, and have quite exhausted their merit by too frequent repetitions, so I will not mention them.

A pure tannic acid was prepared by dissolving the C. P. tannin of commerce in water, filtering, evaporating cautiously, and with additions of acetic acid, to dryness, washing the residue with absolute alcohol to remove gallic acid to prevent drying, dissolving in ether containing some water, and separating it from this by evaporation, drying finally in the air bath at a low heat; the product was pure and white. A solution was prepared holding four grammes of it to a liter of water, and was precipitated after rendering slightly alkaline with ammonia, by a ten per cent. solution of ammonio-sulphate of copper; the precipitate was allowed to settle, then transferred to the filter, and well washed with water containing a minute quantity of ammonia; it was then heated and dried at eighty-five degrees C. in the protected air bath; a portion of it was examined for ammonia, with negative results, no nitrogen compound being detectable; two portions were then taken of 0·5 gramme each; one of them was dissolved in acidulated water, and the copper precipitated with hydric sulphide; the precipitate was dissolved after a thorough washing with both hydric sulphide water and water in nitric acid, etc.; this last was displaced with sulphuric acid, and the copper precipitated as metal, of which there was 11·68 grms., equal to 0·1386 grm. oxide, or 27·719 per cent.; the other portion was burnt, and yielded a formula, $C_{17}H_{12}O_{11}$, with three equivalents of cupric oxide.

It was in black lustrous masses, quite insoluble in cold water, but partly soluble in hot or boiling water, from which it is mostly deposited on cooling in alcohol gallic acid solutions, and in presence of alkalies quite insoluble. It is readily soluble in water acidulated with a mineral acid, but is precipitated unaltered on neutralizing the acid. For the other determination about 100 grammes of hemlock bark was taken and boiled with the decoctions, when cooled was filtered, and some dilute sulphuric acid added to the filtrate, which was again filtered, and the tannic acid precipitated from this filtrate exactly as above. The wet analysis yielded 0·1108 grm. copper, or 0·13773 grm. oxide, or 27·58 per cent., showing it to contain about 99·5 of tannate of copper as compared with the above, the combustion showing the same formula also, the figures differing by a small part. By these results we may readily observe that the tannate of copper formed is quite pure, and all the tannic acid is precipitated, thus setting aside all questions of inaccuracy of the method. Gallate of copper was prepared, and was found to be readily soluble in presence of free ammonia and acids, and quite insoluble in water; also that there is no double compound of gallic and tannic acid with copper.

N. H. DARTON.

319 Pearl St., New York City.

* Read before the American Chemical Society, Feb. 3, 1882.

ON THE SEPARATION OF ALUMINA AND IRON FROM MANGANESE WITH AMMONIA.*

By NELSON H. DARTON.

THE method proposed by Rose some years ago† for this separation is this:

"The solution sufficiently diluted and acid is mixed with some chloride of ammonium and heated to boiling. A fair excess of ammonia is added, and the mixture kept boiling gently for some time until all excess of free ammonia is expelled. It is then filtered, and the iron and alumina oxides on the filter thoroughly washed, the manganese remaining in solution in the filtrates and washings. If the quantity of manganese present was small, the precipitate contains hardly weighable traces of it. If, however, much is present, the precipitate is redissolved, and the above precipitation repeated."

This method has been frequently used by chemists generally, in this and other separations, its only fault lying in the fact that when a large proportion of manganese, a fair portion of alumina, and a little iron are present, it is difficult to obtain the precipitate free from manganese at the first treatment and reprecipitation, and thus leads us to use another method, saving us this inconvenience. Noticing the proportional discrepancies arising in this method, and wishing to find the point of maximum freedom of the precipitate from manganese, I investigated the process, and have prepared this table, showing the influence of the different proportions of the oxides of these three elements upon the proportion of manganese present in the precipitate. Compounds differing by 25 per cent. were taken, and the results are tabulated in per cents of the three oxides, sesqui-iron, alumina, and proto-manganese.

Iron.....	75	0·75	75	75	50	50	50
Alumina..	20	0·10	5	0	40	25	0·10
Manganese	5	0·15	20	25	10	25	40
1st Precip. Mn	0·82	1·03	2·16	2·00	0·64	2·7	4·27
2d do....	none	mere trace	small trace	0·04	none	little	0·09
Iron.....	50	25	25	25	25	0	0
Alumina..	0	50	25	75	70	75	50
Manganese	50	25	50	0	5	25	50
1st Precip. Mn.....	2.3	2·24	4·24	5·32	4·9	1·93	3·03
2d do....	0·43	trace	0·11	0·145	0·106	none	0·43

These figures were obtained all under the same conditions as regards temperature, etc. Although they show no connection with each other, show that when over 40 per cent. of manganese is present in a compound, it had better be separated by some other method, one bringing into use an acetate, under which conditions the iron, etc., can be separated without contamination. However, Dr. Waller tells me that the conditions are about the same in this method, but in a modified degree.

* Read before the American Chemical Society, March 3, 1882.

† *Pogg. Annal.*, 110, 304 307.

TO DISSOLVE SILVER FROM SILVERED ARTICLES.

COLD BATH.—For dissolving silver in the cold, the objects are hung in a large vessel fitted with the following mixture: sulphuric acid, 66° Baume, 10 parts; nitric acid, at 40° Baume, in which they remain for a greater or less length of time, according to the thickness of the coat of silver to be dissolved. This liquid, when it does not contain water, dissolves the silver without sensibly corroding copper and its alloys; therefore, avoid introducing wet articles into it, and keep the liquid perfectly covered when not in use. As far as practicable, place the articles in the liquid so as not to touch each other, and in a vertical position, so that the silver salt will fall to the bottom. In proportion as the action of the liquor diminishes, pour in small and gradual additions of nitric acid. Dissolving silver in the cold is regular and certain, but slow, especially when the proportion of silver is great. The other more rapid process is then resorted to.

HOT BATH.—Nearly fill a flat pan of enameled cast-iron with concentrated sulphuric acid, and heat to a temperature of from 300° to 400° Fahr.; at the moment of using it, pinches of dry powdered saltpeter are thrown into it, then hold the article with copper tongs in the liquid. The silver rapidly dissolves, and the copper or its alloys are not sensibly corroded. According to the rapidity of the solution, more or fewer pinches of saltpeter are added. All the silver has been dissolved when, after rinsing in water and dipping the articles into the cleansing acids, they present no brown or black spots—that is, when they appear like new metals. These two methods are not suitable for removing the silver from wrought and cast iron, zinc, or lead; it is preferable to invert the electric current in a cyanide bath, or to use mechanical processes. Old desilvering liquors become green after use; to recover the silver, they are diluted with four or five times their volume of water; then add hydrochloric acid, or common salt. The precipitation is complete when the settled liquor does not become turbid by a new addition of common salt or by hydrochloric acid. The resulting chloride of silver is separated from the liquid either by decantation or filtration, and is afterward reduced to the metallic state by one of the methods which will be described.

FIXATION OF ALUMINA AS A DISCHARGE ON INDIGO-BLUE BY MEANS OF ALUMINUM CHLORIDE.

By G. SAGET.

THE property of hydrated aluminum chloride to be decomposed into alumina and hydrochloric acid when dried, may be used for obtaining a discharge on indigo blue, while alumina is deposited where the chloride has been printed, and may serve as a mordant for various colors. On adding manganese peroxide to the aluminum chloride, Scheele's reaction is obtained upon the tissue, the nascent chlorine destroying the coloring matter and producing whites. This reaction requires the presence of water and a temperature of 100°. The aluminum chloride must be perfectly neutral. To prepare it alumina is thrown down from aluminum sulphate by means of ammonia. It is collected upon a filter, washed, and dissolved in pure hot hydrochloric acid, taking care always to have an excess of alumina. The clear liquid is decanted and evaporated until a crystalline layer forms on the surface. The chloride is then of a sirupy consistence, and partially crystallizes on cooling. When it is to be used the crystals must be thoroughly mixed with the supernatant liquid. As for the manganese peroxide it is preferable to use that formed by the action of chloride of soda upon a salt of manganese, washing, and drying at 100°. The commercial peroxide contains too much impurities. The product thus obtained is reduced to an impalpable powder. The following discharge is then printed upon a medium indigo blue:

Manganese peroxide	80 grms.
Aluminum chloride.....	300 "
Calcined starch.....	200 "
Water.....	420 "

After printing, the pieces are steamed without pressure for an hour and a half, letting the vapors escape. There is obtained thus a design which is of a pinkish white, and which is cleared by a passage through weak hot hydrochloric acid. If the alumina is intended to serve as the mordant for a color the pieces are washed in hot water, then in cold water, and dyed. In this manner the author has obtained upon indigo blues fine designs in alizarin reds, fustic, or quercitron yellow, cœrulein greens, etc. The discharge above given is intended for a medium blue; for a light or a dark shade it must be let down or strengthened in proportion.

A precaution to be taken when preparing this discharge is to add the aluminum chloride last, otherwise there are formed clots very difficult to get rid of. The peroxide and the calcined starch are first mixed, then the water is added, and when the paste is very smooth the aluminum chloride is stirred in by degrees. This discharge keeps well for a long time in a cool place. Manganic oxide may be substituted for the peroxide, but to obtain the same quantity of chlorine, a double proportion of aluminum chloride is preferable. Hence, from an industrial point of view, the peroxide is preferable.

Lead peroxide gives with aluminum chloride an analogous reaction. The author has sought to prepare a mixture such that after steaming and a passage through a chromate a yellow discharge would be obtained. Unfortunately, such discharges do not keep, and are completely useless after the lapse of a few hours. The contact of the copper rollers decomposes them at once, lead chloride and alumina are precipitated, and hinder the action of the doctors. The result is the same if red lead is employed.—*Moniteur Scientifique.*

ARTIFICIAL INDIGO.

PROF. ROSCOE writes in the *Journal of the Society of Chemical Industry*, No. 1, Vol. I.: "As supplementing the information on this interesting subject contained in my lecture delivered at the Royal Institution in May last, I have now the pleasure of adding the following particulars of Professor Baeyer's observations on his visit to the manufactory of artificial indigo in November last. This shows that the production of artificial indigo is making progress; and I may add that the manufacture is being carried on up to the present day in the manner described by him. It appears, however, that the consumption of propiolic acid is at present limited to a few print works, whose chemists have successfully overcome the difficulties of its application. Let us hope that the great majority of English calico printers will soon follow in the wake of the pioneers. The important question referred to by Professor Baeyer in his letter, viz., that of finding a useful employment for para-nitrocinnamic acid, now a waste product in the manufacture of propiolic acid—may possibly receive a solution from the recent researches of Otto Fischer on the synthesis of the rosaniline dyes, by means of para-nitro-benzaldehyde, a body obtained by the limited oxidation of para-nitro-cinnamic acid. Another point which requires attention is the loss of material incurred in the passage from propiolic acid to indigo. If this loss can be avoided, and if a use is found for the para acid, there seems no reason why indigo blue should not be itself obtained in course of time by Baeyer's reactions, particularly as cinnamic acid can now be made in any quantity, and at a very low price.

"That these researches are only the first steps in the production of colors from the indigo group of compounds is shown by the fact that Professor Baeyer, in February last, patented the production of another coloring matter, termed by him 'indoin.' This resembles indigo in color, and is obtained by the action of concentrated sulphuric acid upon ortho-nitro-phenyl-propiolic acid, when isatogenic acid is formed, and this is converted into the coloring matter by the action of ferrous sulphate. The soluble sulphurous acid compound of indoin is remarkable, and may become useful as a dye."

The following extracts from Professor Baeyer's letter will

be of interest: "Propiolic acid is at this moment made at Ludwigshafen with the same degree of certainty as is attached to the preparation of any inorganic compound. . . . The first necessity in the technical preparation of propiolic acid is a cheap cinnamic acid. Your celebrated countryman, Perkin, was the first to make this acid by a simple reaction, viz., by heating bitter almond oil with acetic anhydride and acetate of soda. The Baden company simplified this reaction, as far as it can be simplified, and prepared cinnamic acid directly by fusing benzyl chloride with acetate of soda, and thus obtaining the acid without using either acetic anhydride or oil of bitter almonds. This reaction is carried on in large boilers fitted with mechanical stirrers, and gives a very satisfactory yield. Great difficulties were met with in nitrating cinnamic acid; but, thanks to the ability and patience of the chemists to the Baden company, these difficulties have been overcome, and a process has been found by which the operation can be conducted on any wished for scale, and with good results. I was amazed to see hundredweights of cinnamic acid undergoing the operation of treatment with nitric acid, for I remembered how difficult a task it was to work up a single pound in the laboratory. The preparation of ortho-nitrocinnamic acid is carried out, first, by the conversion of cinnamic acid into its ethyl ether. The liquid ether is then allowed to run in a thin stream, together with the requisite quantity of a mixture of nitric and sulphuric acids, into a well-cooled vessel furnished with a stirring apparatus. The solid mixture of ortho and para-nitro-cinnamic ethers thus obtained is heated with alcohol, when the para-nitro-cinnamic ether remains undissolved, the ortho ether being dissolved, and deposited from the alcoholic solution in large yellowish crystals. This compound, on saponification, yields ortho-nitro-cinnamic acid. The conversion of this acid into ortho-nitro-phenyl-propiolic acid is carried out in two consecutive operations, both of which work well. The ortho acid is first acted on by bromine, by which means the dibromide is formed, and this is then dissolved in caustic-soda lye, when the soda salt of propiolic acid is formed. Propiolic acid itself is precipitated from the solution of the soda salt by means of an acid, and, after washing, it is sent to market as a paste. Artificial indigo is not itself manufactured in the works, the coloring matter being deposited by the printer himself in the fiber of the cloth from propiolic acid, as is aniline black from aniline. For this purpose a mixture of propiolic acid and xanthate of soda, to which a proper amount of thickening has been added, is printed on the cloth. The color makes its appearance on exposure to the air (aging). It is found to be fast, and exhibits the characteristic tints of indigo in both light and dark shades.

"The series of operations necessary for passing from toluene to indigo blue are, as is seen, rather long, but each process works so regularly and well that the preparation of propiolic acid and its conversion into indigo blue can be carried out with perfect ease. The only serious imperfection in the process is the loss of 40 per cent. of the cinnamic acid in the form of para-nitro-cinnamic ether. This will, it is to be hoped, be overcome by the employment of the compound for some useful purpose. On my visit to Ludwigshafen last November, I found the manufacture of indigo in full activity—200 kilogrammes of propiolic acid paste, containing 25 per cent. of the dry acid, were produced every day, and this is sold at the price of ten shillings the kilogramme."

HOW "WINTERGREEN OIL" IS MADE. *

By GEORGE W. KENNEDY, Ph.G.

THE following account of a visit to an oil of birch distillery, at Middleport, Schuylkill county, Pennsylvania, was read at the January Pharmaceutical meeting of the Philadelphia College of Pharmacy:

In locating a place for the distillation of the oil, there are several things to be taken in consideration. First, to have an abundance of material conveniently at hand, so that the supply may not soon be exhausted; and second, a good supply of water. The above-named place in these respects seems to be a very desirable spot for some time to come. I was told by the proprietor that sometimes the teaberry-leaf is used exclusively, at other times the birch and wintergreen are mixed, and at this season of the year birch is used to the exclusion of all others; the oil extracted from all is mixed, and sold as oil of wintergreen. For a long time the oil of birch, wintergreen, and of other plants have been considered almost identical, if not altogether so, and it was one of my objects in making this visit to obtain the oil of birch bark, with the view of applying to it the usual tests for oil of wintergreen, the result of which will be given further on.

The species of birch used is the *Betula lenta*, commonly known in this locality by the names of cherry, sweet and black birch. It grows to the height of 75 feet; but as generally found is from 10 to 25 feet high. The bark is very sweet-aromatic; the leaves are ovate or oblong-ovate, form a more or less heart-shaped base; acuminate, sharply and finely double-serrate; when mature shining and bright green above, and glabrous, except on the veins beneath. It is found in moist woods, and grows north from New England to Illinois, and along the Alleghenies southward.

The first step in the preparation of the oil is the gathering of the bark, or rather of the tree, as the whole tree is used, except a few small sprouts near the ground. These are left undisturbed, and in five years will be found to have grown to the height of 8 to 10 feet, and are then considered large enough to be cut for the extraction of the oil. It will be observed that from the stumps of trees used this year, a new growth may be used five years hence, and so on every five years; this industry does not, therefore, involve the destruction of the trees, as one would naturally suppose. The small trees are preferred, and are gathered by a man, for which he is paid about three dollars per ton delivered, besides the payment to the owners of the land of one dollar per ton for the privilege of cutting the trees, making in all four dollars per ton for the trees delivered at the place where the oil is manufactured.

The trees are then submitted to a chopping machine, containing two large knives, about eighteen inches long, and three to four inches wide, made strong and heavy, and which are so arranged that they are operated by a wheel, similar to that in the ordinary drug mill; for every revolution of the wheel the knives cut four times, and it requires but a short time to cut a ton of the material into pieces from one to four inches long, in which condition they are ready for the stills. These consist simply of heavy wooden boxes with copper bottoms, resting on a stone foundation, built about 15 to 18 inches above the surface of the earth, a place being made for fire. Wood is used altogether for fuel. The dimensions of the box or still are 4 × 6 feet and 3 feet high.

The material being ready for distillation, it is placed in the still, as much as this will hold, and a sufficient quantity of water is added to fill the still about one third full. The still is generally permitted to remain in this condition over night, a fire is made in the morning, and distillation proceeds nicely. The condensers used are of two different kinds, one being the ordinary copperworm placed in a large barrel, while the other is made of copper pipe, about 2 inches in diameter, and shaped like a letter U, each wing being 12½ feet long, and placed in a trough. A stream of cold water is constantly passing into the barrel and trough, and is carried several hundred feet by a wooden gutter, from a clean clear creek of spring water. The condensed steam in the condenser consists of water and oil. The U-shaped condenser, the distiller says, is more desirable than the other, because the first portion of distillate contains oil, while in the old worm style several bucketfuls of water pass out before a drop of oil makes its appearance. As the liquid comes from the condenser a novel contrivance is used for collecting the oil and water, consisting of a Mason's fruit jar (two quart size), complete; a small tin funnel is placed in the metallic cap of the jar at one side, and extends below the cap, the condensed liquid runs through the funnel into the jar, and as the weight of the oil is greater than that of the water, it sinks to the bottom of the receiving vessel. The water runs out through a pipe fastened into the cap on the side opposite to that where the funnel is inserted, is conducted into a bucket, and finally emptied into a barrel, to be used again for the next lot of material. The advantages of using the same water in successive operations are apparent. When distillation ceases, the crude oil thus obtained, containing a little water and fragments of vegetable matter, is emptied into a can, with a broad flat spigot fastened as close as possible to the bottom; the impurities float on the surface, and the clear oil is then drawn off through the spigot.

The rectification of the oil is accomplished in a very short time, the process being decidedly simple; but as I was requested and promised not to make it known at the present time, I regret that I am compelled to withhold this valuable information, since the perfection of this process has cost Mr. Seidle a considerable sum.

The odorous principle seems to be thoroughly extracted from the bark, and after the distillation the contents of the still have not the faintest aromatic odor or taste.

It is generally understood in preparing the volatile oil from birch bark to be absolutely necessary to submit the material to maceration with water, before distillation, in order to develop the oil. The distiller informed me that he obtains the oil occasionally from birch as well as from teaberry, without previous maceration. Sometimes the bark is covered with ice and snow. As stated before, the material is generally placed in the still the night previous to commencing distillation in the morning. The steam generated passes up through the drug, and extracts the oil in its upward exit; but only about one-third of the bark is covered with water in the still. When the bark is macerated the yield is about 20 per cent. larger.

There are three layers of bark on the wood. The outer thin tissue contains no oil; the next, or middle layer, is of a greenish color, and likewise contains no oil; the inner layer, next to the wood, which is much thicker than the others and more spongy, yields the oil. Mr. Seidle informs me that during the month of October, or about the time the leaves fall, little if any oil is made, on account of the small yield, hardly reaching 80 per cent. of the yield of any other month during the year. The bark is never dried, but cut up and placed in the still in its green condition, and the oil extracted.

Water running from coal mines cannot be used in the distillation, because it contains sulphur and its compounds, which seem to act very destructively on the yield, causing a falling off of at least 75 per cent.; that is to say, instead of obtaining 4 pounds of oil, but 1 pound is obtained, and this of a bright blood red color.

The yield of oil from birch, using the whole tree in a green state, is 5 pounds from a ton of 2,240 pounds, or 0·23 per cent. The yield obtained from wintergreen herb averaged 18 pounds from a ton of 2,240 pounds, or about 0·80 per cent.; but the latter plant is considerably more expensive to gather, costing at the lowest calculation about thirty dollars per ton, and in this locality labor cannot be procured at that price, since the gathering of the herb is very tedious, and the laborer can scarcely earn sufficient to live on.

The oil of *Betula lenta*, obtained as above described, is entirely colorless, of a strong and agreeable aromatic odor, and of a sweetish aromatic taste. I have found it to have a specific gravity of 1·178, about the same as that of oil of wintergreen. The oil boils briskly at from 424° to 436°, and the boiling point rises to 442° F., where it remains stationary, a litter higher than that of oil of teaberry, which is said to be 431° F. The oil, on being heated to boiling, changes in color from colorless to a light reddish-brown.

Like oil of gaultheria, with ferric chloride in water, it produces a dark violet color, and with concentrated solution of soda or potash a solid crystalline mass is formed. Heated with nitric acid, orange-yellow crystals are produced, nitrous acid fumes being at the same time given off, and when treated with cold nitric acid, crystallization takes place, forming methyl-nitrosalicylate. Treated with muriatic acid, after standing several days, white crystals are formed in quantity.

On adding 1 drop of the oil to 1 ounce of lime water, the odor entirely disappeared, and a very voluminous white precipitate of methyl-salicylate of calcium occurred, the same as oil of teaberry, previously noticed by Mr. Wellcome (*Am. Jour. Phar.*, 1875, p. 426). With sulphuric acid a dark red color is produced. This would account for the oil being red when coal mine water is used in its extraction. Treated with iodine the color becomes much darker, and the oil of a sirupy consistence. In all respects, except the slight difference in the boiling point, the oil appears to be identical with that of oil of teaberry.

* From the *American Journal of Pharmacy*, February, 1882.

DECOMPOSITION OF GLUCOSE AND URIC ACID.—Glucose is decomposed, while sugars of the formula $C_{12}H_{22}O_{11}$ have a greater power of resistance. Cane sugar remained unaffected. Proteine compounds underwent no profound decomposition on contact with dilute alkalies. On digestion for days with an excess of alkali, there was a slight escape of ammonia, and peptons were formed. Leucin, tyrosin, and glycocoll were not generated. Uric acid was rapidly decomposed by dilute alkalies.—*M. Nencki and N. Sieber.*

BISMUTH OXIDE AS AN AGENT FOR OPENING UP SILICATES.

By WALTHER HEMPEL.

GASTON BONO has proposed to open up silicates by fusion with lead oxide, decomposing the unstable compounds formed with nitric acid, and after eliminating the lead by means of sulphureted hydrogen, proceeding with the analysis in the ordinary manner. This method offers great advantages, since melting lead oxide quickly decomposes the most refractory silicates, even if not in the finest state of mechanical division. In conjunction with my assistant, Dr. R. F. Koch, I have made a number of experiments with this agent, and have found it very difficult to prepare a chemically-pure lead oxide. The red lead and the litharge of commerce we found always containing silica along with other impurities. The preparation of chemically-pure lead oxide from metallic lead by dissolving it in nitric acid and igniting the nitrate thus formed, involves great mechanical difficulties, since the lead nitrate melts before decomposing, and froths strongly, so that small quantities only can be obtained in each operation. All these difficulties are overcome by substituting bismuth oxide for lead oxide, simply igniting the silicate in question with bismuth subnitrate.

This compound is easily obtained in a state of the utmost chemical purity, and it has the further advantage that it does not melt at its temperature of decomposition. The opening up can be performed in the smallest platinum crucibles, as the hyponitric acid liberated fumes slowly away and does not carry with it any of the substance. The resulting melt is dissolved in hydrochloric acid, while in the lead process nitric acid is required, which must be afterwards expelled.

Repeated experiments have shown that it is advisable to work with a large excess of bismuth oxide, so as to have a very basic melt, which is easily decomposed by means of hydrochloric acid. The operation succeeds easily if one-half gramme of a silicate is heated gently with ten grammes of bismuth subnitrate till red fumes no longer escape, and is finally kept in fusion for about ten minutes. The melt is poured as far as possible while still liquid into a platinum capsule floating upon cold water, and the mass thus obtained and the crucible are treated with concentrated hydrochloric acid. The solution thus obtained is evaporated to dryness for the elimination of silica; the residue is taken up with hydrochloric acid; the silica filtered off, and washed with water acidulated with hydrochloric acid.

On diluting the filtrate with water the greater part of the bismuth is precipitated as oxychloride. It is filtered off, washed, and from this second filtrate the remainder of the bismuth is precipitated by means of sulphureted hydrogen. The further treatment of the filtrate is effected in the ordinary manner.

In order to throw a light upon a possible error due to the volatilization of the alkalies at the melting temperature of bismuth oxide, a feldspar was decomposed by this method, and by the hydrofluoric process. The results were:

With bismuth—		
Potassa	7·60,	7·70
Soda	4·71,	4·72
With hydrofluoric acid—		
Potassa	7·86,	7·77
Soda	4·79,	4 84

The operation can be safely conducted in a platinum crucible if care be taken that it is not in a reducing atmosphere. If reducing gases are present, metallic bismuth is formed, which destroys the crucible. Silicates which contain organic matter must first be ignited with access of air. A number of meltings have been performed in the same crucible, which suffered no injury.

As bismuth is a costly metal it is prudent to work up all the precipitates into subnitrate. This may be conveniently done by melting the residues and the filters along with soda in a Hessian crucible, dissolved in nitric acid the metallic bismuth thus obtained, and precipitating the solution with water as a basic nitrate.

Finally I must recommend that the decomposition of silicates should be effected under a drought-hood, as the bismuth oxide volatilizes slightly at the melting point, and the vapors seem to be very poisonous.—*Zeitschrift für Analyt. Chemie.—Chem. News.*

NOTE ON THE VOLUMETRIC ESTIMATION OF ZINC, BY TITRATION WITH POTASSIUM FERROCYANIDE.

By ROBERT W. MAHON.

ACCORDING to a method previously described for the volumetric estimation of zinc, a standard solution of potassium ferrocyanide is obtained by titrating a solution of known strength of pure zinc, dissolved in hydrochloric acid. After each addition of potassium ferrocyanide a drop of the solution is tested with a drop of a solution of uranium acetate, to ascertain whether the whole of the zinc has been converted into ferrocyanide, and an excess of the potassium ferrocyanide added. As soon as an excess of potassium ferrocynide is added, a brown spot is obtained by bringing a drop of the solution in contact with a drop of uranium acetate solution. For the determination of zinc in its ores, they are dissolved in nitric and hydrocholoric acids; and those metals whose sulphides are formed in acid solution are precipitated by sulphureted hydrogen. After filtering, the iron is oxidized with nitric acid, and precipitated by addition of ammonium hydrate in excess, the zinc remaining in solution. The ammoniacal filtrate is made slightly acid, with hydrocholoric acid, and, in the absence of manganese, is now ready for titration. In the case of Franklinite and other zinc ores containing manganese, this method for the estimation of zinc is not as easy of application as when manganese is not associated with zinc in the ore.

In the original paper describing the method, Fahlberg* directs that, after the separation of iron by excess of ammonia, the ammoniacal filtrate be made acid with excess of hydrochloric acid, and that the titration be made into this acid solution. The statement is made that the presence of manganese will not interfere with this titration. This statement I find to be erroneous. Both the manganese and zinc will be precipitated, even in a solution acid with hydrochloric acid. And, moreover, it is not possible to make the solution sufficiently acid to prevent such precipitation. When to a very dilute solution of a salt of manganese, in pure water, potassium ferrocyanide is added, the manganese is not at once precipitated. If ammonium chloride is present

* *Zeitschrift fur analytische Chemie*, 13, 379.

(the condition i the actual analysis), the precipitation will be more nearly instantaneous. When the quantity of manganese is considerable, the precipitation will occur at once, even in the absence of ammonium chloride.

The presence of manganese is then not allowable, even in small quantities, in the solution with zinc, where zinc is to be estimated by titration with potassium ferrocyanide. No way of precipitating maganese and leaving zinc in solution presents itself, as any precipitation of manganese by oxidation would necessarily carry down considerable quantities of zinc with it; such a precipitation, for example, as that of the oxides of manganese out of the solution of the acetate by addition of bromine water. This method for the separation of manganese and zinc, although frequently employed, is not permissible, as the precipitated oxides of manganese will carry down considerable quantities of zinc with them. In order to get a solution for titration when manganese and zinc are associated in an ore, it is necessary to precipitate the zinc as sulphide out of the solution strongly acid with acetic acid by sulphureted hydrogen, and to redissolve this precipitate in hydrochloric acid.

Dr. Fahlberg informs me that, since his communication above referred to, he has also observed the precipitation of manganese by potassium ferrocyanide in hydrochloric acid solution.—*Amer. Chem. Jour.*

APPARATUS FOR VERIFYING THE ILLUMINATING POWER AND DENSITY OF ILLUMINATING GAS.

RHEOMETERS, or volume regulators, for rendering constant the consumption of an isolated burner, have already been described. The rheometer is the base of the *photo-rheometer*, of the *verifier of the value of gas*, and of the *burner analyzer* that we are about to describe.

It is this apparatus which has permitted of a burner with a single aperture being placed under conditions such that the flame produced becomes a unit of light—a standard upon which may be based all operations; and that, too, the more, inasmuch as in photometric experiments the standard re-establishes itself, and thus does away with all the uncertainties and all the difficulties inseparable from the use of either the candle or oil carcel.

It is known, of course, that, all things being equal, the characteristic intensity of a burner with a single aperture preserves the same value so long as the length of the flame does not vary; so that the measurement of a change of length may serve for measuring a change in intensity. It is this property of the candle-burner that the action of the *photo rheometer* (Fig. 1) has permitted of utilizing for the determination of a unit of light, and establishing a standard.

Fig. 1 sufficiently shows that this apparatus is, in fact, a rheometer, modified in such a way that the pressure during entrance cannot act upon the section of the cone; so that the volume of rheometric consumption can no longer be altered, except by a change in the density of the gas that is flowing.

The gas enters the apparatus through the cock, L, and passing under the movable receiver, G, flows through an aperture in the latter to the burner. The cock, K, has the same role here as in the wet rheometer, serving, through the degree to which it is open, to temporarily modify the section of the rheometric passage. When the cock is closed, the orifice alone of the capsule suffices to distribute 25 liters of gas, of a density of 0·4, per hour; and, for Paris, as long as the gas remains of the regulated quality,

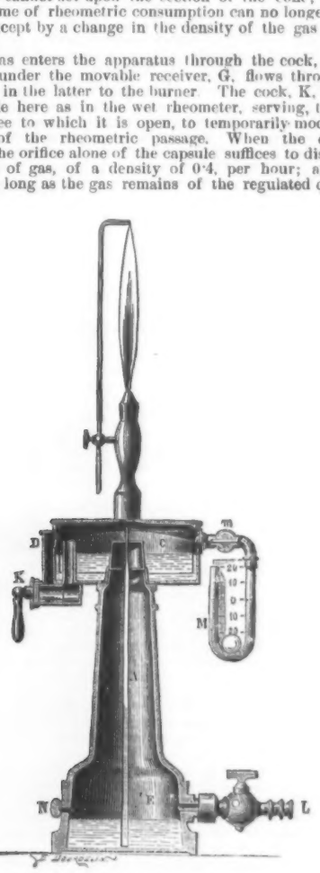


FIG. 1.—PHOTO-RHEOMETER.

the flame produced by these 25 liters is 67½ millimeters in length, and equal to one-tenth of a carcel.

Having a standard thus established, if we wish to measure the intensity of a light produced by oil, wax, etc., it will evidently be necessary to give the standard its height of 67½ millimeters by means of the cock, K, provided such height has not been obtained by the volume given out by the single orifice of the capsule. A difference of half a millimeter corresponds in fact to an alteration of 1·1 per cent. in the characteristic intensity of the standard taken as a unit.

But, were it a question of gas burners, the two lights compared, being produced by the combustion of the same illuminating agent, we should no longer concern ourselves with the length of the flame of the candle-burner. Such length will always be, it is true, 67½ millimeters with Paris gas in its prescribed state; but, if such state changes, the change will have produced the same effect upon the two flames compared; and, as the burner experimented with is supposed to be also regulated by a rheometer, the ratio of the densities will remain the same. In the first case, the value of the standard is *absolute*, while in the second it is simply *relative* to the state of the gas employed; and it is precisely because of this that the results of successive trials become comparable with one another, notwithstanding the changes in the value of the gas due to variations in manufacture.

The Testing Apparatus (Fig. 2) is a simplification of the datum of the photo-rheometer; but the rheometer which here regulates the outflow is not absolutely independent of the variations of the initial pressure. So the changes of length in the flame can only *make known* changes of intensity, without ever being able to serve for showing the cause of it, or measuring it

FIG. 2.—TESTING APPARATUS.

The Verifier of the Illuminating Power and Density of Gas.—This apparatus (Fig. 3) consists of a photo-rheometer, of a small balanced gasometer, and of a carefully regulated seconds counter. In its position shown in the cut, B, which is a three-way cock, directs the gas to the burner. By turning the handle from left to right the gas enters the small gasometer, whose section is known. Then, instead of burning, the volume flowing is measured. The seconds counter is put in motion or stopped by means of the lever, B.

In order to verify the value of an illuminating gas, it is evidently necessary to measure at once the light produced and the volume consumed in the production thereof.

The rule adopted at Paris is that 105 liters of gas per hour burned in the Bengel type should give an intensity equal to that of one carcel burning 42 grammes of oil per hour. When the gas fulfills such conditions, the one millimeter candle-burner of the photo-rheometer gives a flame of 105 millimeters in height, with a consumption of 38 liters per hour. This is the basis upon which the verifier is constructed.

By thus bringing the verification of the illuminating power down to a simple measurement of a length of flame, we eliminate the most fruitful sources of difficulties between the gas works and cities.

At any time that it is desired to control the actual value of the gas, the flame of the candle-burner is given the exact length of 105 millimeters by properly opening the cock, K, and it is seen whether the gasometer floats. Then, after placing the chronometer at zero, the zero of the scale is brought under the index, and the lever, B, is raised horizontally, thus starting the seconds counter at the precise moment at which the gas ceases flowing to the burner and begins to enter the gasometer. Such change of direction in no wise influences the volume of the flow, even if the resistance due to the weight of the gasometer shall differ sensibly from that resulting from the section of the burner.

In about a minute, the lever, B, is shoved back to its initial position, thus simultaneously stopping the seconds counter, and sending the gas to the burner. The chronometer indicates of itself whether the stoppage has been made exactly at the desired moment. If it has been, the figure corresponding to the number of millimeters marked on the scale by the index is sought on the tablet in the lighting-power column. This figure indicates how many liters of control gas should be consumed by the Bengel to give the light of one carcel.

To find the density, the cock, K, is completely closed, and the same process is gone through with, no account being taken this time of the flame's length.

Thus, two successive experiments, of one minute each, suffice to determine the illuminating power and the density of the gas.

The Burner Analyzer (Fig. 4) consists of five rheometers inclosed within one drum, and giving out, in the following order, 10, 20, 40, 80, and 160 liters of gas per hour. The gas given out by these rheometers, when the cocks are opened, enters a common space beneath the coupling, D, and from thence goes to the burner to be tested, which is screwed to the latter. This instrument renders very sensible the difference existing between the *pressure* regulator, and the *volume* regulator. In fact, five pressure regulators placed within the drum of one analyzer, can only give the burner placed at D a constant pressure; and, whatever be the number of regulators in action, the consumption that the burner can make under such pressure will not change. With the *volume* regulator, on the contrary, in measure as the cocks are turned on, the yields of the rheometers accumulate and affect the burner, so that the consumption of the latter becomes modified.

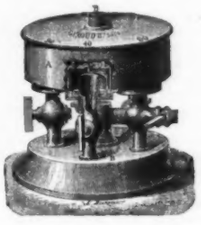


FIG. 4.—BURNER ANALYZER. (½ actual size.)

By combining, as may seem expedient, the use of the cocks, one burner may be made to pass through all consumptions of 10 to 10 liters, from 10 liters up to 310, and to reproduce by a single operation a given consumption, with any burner whatever, without there being any need of having recourse to the meter. A small pressure-gauge, adjusted to the burner support, indicates the pressure necessary to the burner, in order to effect the different consumptions to which it is exposed; and by the sole bringing together of the pressures thus observed, we find ourselves informed as to the relative value of the burners, regarded from the standpoint of light production.

The use of this instrument demonstrates:

That a burner may effect the most diverse consumptions, but that, of itself, it determines none of them; that there are, outside of the rheometric burner, no burners of 80, 100, 200, etc., liters; and that the burner influences only the form and intensity of the flame.

Fig. 5 shows the successive increases undergone by a flame with consumptions of 70 to 175 liters per hour. It will be readily seen how impossible it is to regulate by sight the consumption of a burner to near 80 or 40 liters. An

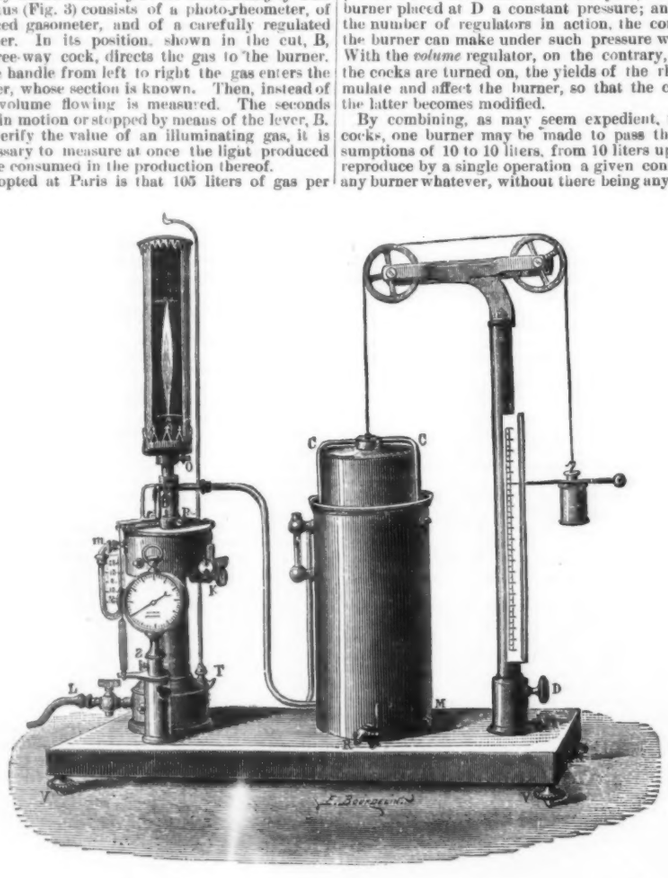


FIG. 3.—VERIFYING APPARATUS.

observation thus made in a closed space, and on a steady flame, would be subject to grave errors, and it is utterly impracticable for lamplighters who are obliged to regulate along public streets, and with a pole, burners that are always more or less agitated by the wind. Such a regulation is supposed to be very nearly exact, simply because its errors cannot be measured.

Fig. 6 represents a complete installation, in a laboratory, of the apparatus designed to verify illuminating gas.

C is an ordinary meter, such as used by consumers. V is the verifying apparatus, such as shown in Fig. 3.

FIG. 5.—FLAME. (Actual size.)

The testing apparatus, E, is a tightly closed bell glass, containing test papers. The current of gas which traverses the bell is measured by a rheometer, so that if the duration of the trials be taken account of, it becomes certain that the coloration of the paper has been obtained by an immersion during a same period in a known *volume* of gas. I is a wet registering pressure gauge. There is, however, a dry apparatus, on the Brouardel system, which answers the same purpose. The gauging gasometer, G, is substituted for the experimental meter for testing burners, and offers the advantage over the former of not multiplying errors. It permits of making tests under all pressures, even during the daytime, and has compensators, which keep the plane of the contained water always at the same point, annulling the effect of the immersion of the tubes and the sides of the bell.

R is a Bunsen photometric screen, with inclined mirrors for rendering the two sides of the spot visible at the same time. A is the burner analyzer, shown at Fig. 4. P is the photo-rheometer, shown in Fig. 1. *m m* are ordinary pressure gauges.

SILICO-MOLYBDIC ACID.

THE author has isolated silico-molybdic acid, perfectly crystallized, in the shape of yellow cubo-octahedra, without action upon polarized light. They melt about 45° in their water of crystallization, and are decomposed below 100°. The acid is very soluble in water and in dilute acids and forms crystalline salts with bases. Alkaline carbonates and ammonia in excess decompose it with a precipitation of silica. Silico-molybdic acid resembles phospho-molybdic acid in color and crystalline form. But it is less stable. Ammonium phospho-molybdate is insoluble, while silico-molybdic acid gives no precipitate with ammoniacal salts, save in very concentrated solutions. Phospho-molybdic acid gives an insoluble compound with potassa, while silico-molybdic acid gives no precipitate, even in the most concentrated solutions of potassium salts. Salts of cæsium and rubidium, even when present in small quantity along with other alkaline salts, may be detected by means of silico-molybdic acid. The rubidium silico-molybdate is slightly soluble, while the corresponding cæsium salt is totally insoluble, by which means the two may be separated.—*F. Parmentier.*

THE SIEMENS REGENERATIVE GAS-BURNER.

AT a recent meeting of the Philosophical Society of Glasgow, an interesting communication was made by Mr. William Foulis, C.E., on "Dr. Siemens' Regenerating Gas Burners," which he illustrated both by colored diagrams and by two burners, one of which was of great power.

Mr. Foulis said that the general principle of both the Siemens burners was that of heating the gas, by the highly heated products of combustion, before it arrived at the burner; and of acting in the same way to the air required for its combustion. The idea was not, he remarked, altogether new. So long ago as the year 1813 it was suggested by the late Professor Faraday; and Dr. Frankland had also, he believed, made several burners in which the idea of heating the gas was suggested. In order that the members of the society might understand the principle on which the burners were constructed, he said he would remind them that coal gas was a compound of carbon and hydrogen, or rather a mixture of various compounds of these two elements; and that the luminosity of a gas flame was due to the incandescence of th small particles of carbon, which by the ordinary method of burning gas were dissociated from the hydrogen gas in the early stages of the process of combustion. The important points to consider in connection with the question of the economical consumption of gas were: (1) that the separation of the particles of carbon should be as complete as possible; and (2) to have the greatest available number of these particles disseminated throughout the flame. The limit of the separation of the solid articles was the point at which the flame began to smoke; and the stage of the combustion process at which the greatest degree of luminosity took place was just the point before the emission of smoke began. Another consideration was that the higher the quality of the gas—or, in other words, the richer the gas was in carbon—the sooner did the point arrive at which smoke was given off. A quality of gas having a luminosity equal to 36 or 40 standard candles gave a flame that could scarcely be consumed, in ordinary burners, without a smoky condition arising. The means adopted for insuring the separation of the carbon particles in the flame was that the gas should be burned under a very low pressure—the gas should issue from the orifice or orifices of the burner almost without any pressure at all. The temperature of the flame should be as high as possible, because in this way not only would the carbon particles be more intensely heated, and thus give out more light, but the greater temperature produced in the flame enabled it to maintain a greater number of carbon particles in the incandescent state.

This was seen very clearly in the Siemens burners which Mr. Foulis exhibited and experimented with. For a period of from 15 to 20 minutes after the gas was lighted there was a good deal of smoke, if the full supply of gas was turned on; but as the burner become sufficiently heated the smokiness diminished, and the stopcock might be turned on full.

The two points thus dwelt on were, said Mr. Foulis, accomplished in the Siemens burners by allowing the gas to issue through a series of comparatively large tubes, and by returning the gaseous products of combustion through the center of the flame, thereby heating the gas to a temperature of from 600° to 700° Fahr. In this way the temperature of the flame was very largely increased. By the use of such burners 16-candle gas gave a light of from 36 to 40 candles; the increase of the illuminating power being more than 50 per cent. Mr. Foulis said he believed that the burners were susceptible of being still further improved. The two Siemens burners exhibited were burning—one at the rate of 4 cubic feet per hour, and the other 20 feet per hour; indeed, the latter, which was provided with a very large concave reflector, seemed to be yielding almost as much light as the two sunlights in the lecture hall, which were consuming about 150 cubic feet of gas per hour.

ON THE TRANSFORMATION OF OZONE INTO OXYGEN BY HEAT.

By IRA REMSEN.

IT is known that when ozone is heated to about 200° it is converted into oxygen. Accepting the prevalent view concerning the nature of ozone, but two conceptions regarding this transformation appear at all probable. If the molecule of ozone contains three atoms, and that of oxygen two, then the transformation of the former into the latter by heat consists, first, in the partial decomposition of the molecule, either into a molecule and an atom of oxygen, or into free atoms only; and, second, in the recombination of the free atoms to form molecules of ordinary oxygen. Though the interval of time between the decomposition of the ozone and the formation of the oxygen molecules may be infinitesimal, there must apparently be this interval, and then the oxygen should be in its most active state with the powers that characterize nascent oxygen. But ozone itself, as is well known, is a strong oxidizing agent, so that to distinguish between nascent oxygen and ozone appears at first to be a very difficult problem. A recent interesting communication* by E. Baumann shows how this may be done, and I am hence led to describe an experiment which was performed in this laboratory some time since by Mr. P. H. Broun, the results of which are especially noteworthy, as they seem to throw some light on the processes involved in the transformation of ozone into oxygen under the influence of heat.

Southworth and I have shown† that ozone does not oxidize carbon monoxide. Baumann confirms this, and further proves that nascent oxygen, obtained by the action of palladium-hydrogen on oxygen, does transform the monoxide into the dioxide. This difference in the conduct of the two substances furnishes a means of distinguishing between them. If in any gaseous mixture there is ozone and no nascent oxygen, carbon monoxide will not be oxidized by it. On the other hand, if nascent oxygen be present, carbon monoxide will be converted into carbon dioxide.

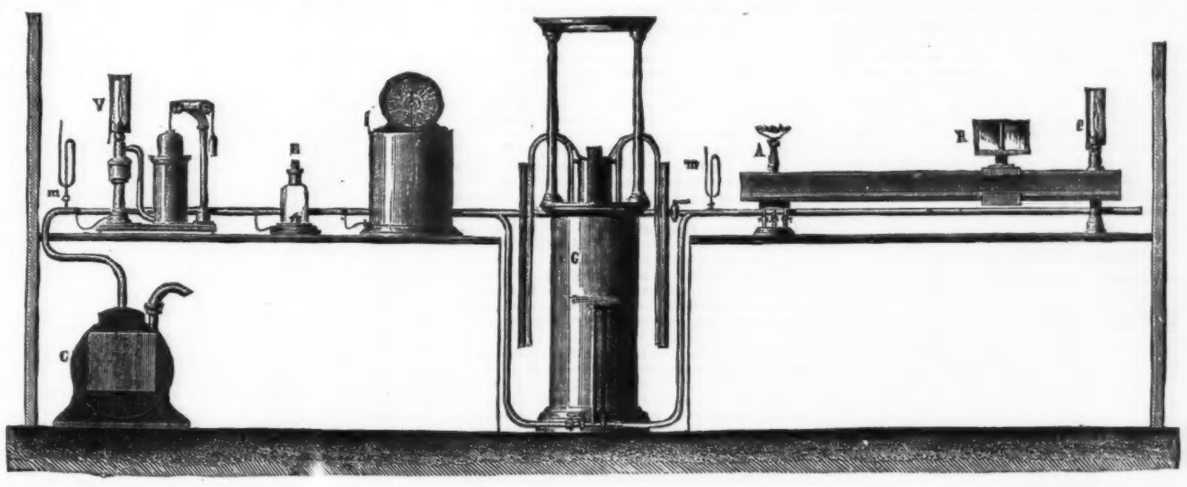


FIG. 6.—APPARATUS FOR VERIFYING GAS.

Having proved beyond a doubt that carbon monoxide is not oxidized by ozone at the ordinary temperature, it remained to determine at what temperature the oxidation is effected. It seemed probable that this temperature would be below that at which ozone is transformed into oxygen, or, if not, then at least at the transformation temperature. Mr. Broun's experiments, above referred to, led to what appears to me to be an astonishing result, viz., that carbon monoxide is not oxidized by ozone even at the temperature at which the ozone is transformed into oxygen. For various reasons the experiments were left in a somewhat unsatisfactory shape, and recently, at my suggestion, they have been repeated by Mr. E. H. Keiser. Every precaution was taken to avoid error, and the result reached fully confirms the conclusion just stated. Before discussing this result in its relations to the nature of the molecule of ozone, I will describe in detail the experiments which led to it.

A gasometer was filled with pure carbon monoxide, made from potassium ferrocyanide and sulphuric acid, and purified by passage through four wash-bottles containing caustic

* *Zeitschrift fur physiologische Chemie*, 5, 244.

† *American Journal of Science*, 11, 136; and *Berichte der deutschen chemischen Gesellschaft*, 8, 1415.

soda solution. Another gasometer was filled with pure oxygen. In the first experiments the oxygen was ozonized by means of a Siemens tube connected with an efficient induction coil. It was afterward found, however, that much stronger ozone could be obtained by the use of Wright's tube connected with a Holtz electric machine. It is hence only necessary to describe one of the experiments made with the latter form of apparatus. A slow current of oxygen from the gasometer was passed through three wash-bottles containing caustic soda solution, and then through the ozonizer. The ozone was tested and found to be unusually strong. The greatest care had to be taken to avoid the exposure of rubber to its action, as it required but momentary contact to effect the perforation of the rubber. The carbon monoxide was passed through wash-bottles containing caustic soda solution, and finally through baryta water. The two gases were then brought together in a U-tube placed in an air-bath. After leaving the U-tube the gases passed through perfectly clear lime-water. The mixture in the U-tube was heated gradually to about 300°. Under these conditions the current of the gases was continued for an hour, and no precipitate was formed in the lime-water. Separate experiments were made for the purpose of determining how readily the ozone was destroyed, and it was found that, even when the thermometer in the U-tube indicated a temperature considerably below that stated as the decomposition temperature of ozone, and when highly ozonized oxygen was certainly passing into the U-tube, no ozone passed out, whether carbon monoxide was present or not in the tube at the same time. The experiment as above described was repeated several times, but always with the same result. One modification of the experiment should also be mentioned in this connection. In order to get as good ozone as possible, the ozonizer was filled with oxygen, and the current of gas then stopped. The oxygen was left in the tube for a minute or two, and then passed slowly into the heated U-tube containing the carbon monoxide. This interrupted current of oxygen was continued for about an hour, but no oxidation of carbon monoxide to the dioxide could be detected.

It is difficult to see how the fact thus established can be explained, if we accept the prevailing ideas concerning the nature of ozone, and its transformation into oxygen by heat. That carbon monoxide can unite with oxygen when the latter is in proper condition is established. We cannot conceive of a more favorable condition for this union than that presented by free atoms of oxygen. When ozone passes into the form of oxygen under the influence of heat, are there not formed free atoms of oxygen? If not, then how does this change take place? If the molecule of ozone consists of an odd number of oxygen atoms, free atoms must apparently be formed during the change. We may, to be sure, conceive of the change as possibly taking place in this way. Two ozone molecules, after being partly broken up, may unite, forming a more complex molecule of six atoms, and this may then break up in pairs of atoms or into oxygen molecules. Even this would involve, as far as we can form any conception of such a process, a temporary increase in the activity of the oxygen. Speculation in this direction can, however, have but very little value at present.

Another thought suggests itself. Hoppe-Seyler and Baumann hold that the energetic oxidizing action of palladium-hydrogen and oxygen is due to the formation of nascent oxygen. While this explanation appears probable, it certainly lacks adequate proof. The action may be more complicated than this explanation would make it appear. On the other hand, Moritz Traube's statement* that the action is due to the formation of hydrogen dioxide would appear to be disapproved by the fact that, while carbon monoxide is oxidized by palladium-hydrogen in the presence of oxygen, it is not oxidized by hydrogen dioxide, as was shown by me some time since.† The experiments upon which my statement on this point was originally based have been recently repeated in this laboratory by Mr. E. H. Keiser, and the result first stated shown to be correct. Even when carbon monoxide is passed into a solution of hydrogen dioxide which is undergoing rapid decomposition by heat, no oxidation is effected. This result is just as inexplicable as the negative result obtained with heated ozone.

Further experiments are called for to determine whether there are not conditions under which hydrogen dioxide can oxidize carbon monoxide. Possibly the presence of one of the many substances known to have the power to decompose the dioxide may at the same time increase its oxidizing power.—*American Chem. Jour.*

REVERTED PHOSPHATES.

AT a recent meeting of the American Chemical Society, New York a paper was read "Upon the Determination of Reverted Phosphates," by Mr. Thos. S. Gladding. The author pointed out the distinctions between the different modifications of phosphates, and the great necessity of noting them in an analysis. The various methods of separating the different phosphates were then discussed, and as the result of elaborate experiments he shows that the Fresenius or Washington method is quite erroneous, as the solubilities are influenced by a number of causes, the principal one being heat—this also being true of the Cincinnati method, but to a less extent. But little discussion followed the reading of this paper. Dr. Doremus asked some questions upon the solubility of the phosphates in solutions of diluted hydrochloric acid.

The second paper of the evening, by Mr. Nelson H. Darton, was then read, upon the "Refining of Low Grade Butters." Mr. Darton briefly described a process in which the butter after washing was treated with chlorine in a peculiar apparatus, and the butter after this well washed and for flavor treated with fir chips. It is then, after the auxiliary treatments of coloring, salting, etc., pressed through cloth and sent to market; the only thing debarring this process from entire mercantile success being that the low grade butters at present to be had are generally so mixed with salt-rags, water, etc., that a large loss is incurred by their rejection. The cost of refining by this process is two cents per pound, and the product an excellent cooking butter. In the discussion which followed, Dr. Doremus mentioned his experience in treating low grade butters, and said that the only difficulty encountered was in obtaining a steady supply, and of noncontaminated butters.

BY WHAT ACID DO PLANTS EFFECT THE SOLUTION OF THE PHOSPHATES IN THE SOIL?—The author maintains that this change is effected by oxalic acid, and he suggests potassium oxalate as a solvent for reverted phosphates in manures in preference to ammonium citrate.—*H. Von Liebig.*

Berichte der deutschen chemischen Gesellschaft, 15, 222.
†*Ibid.*, 9, 1876.

THE IRRITATING EFFECTS OF CARDOL.*

By MRS. IDA R. BRIGHAM.

THE oleaginous liquid contained in the pericarp of the cashew nut is, according to Professor Staedler, a mixture of about ten per cent. of cardol, ninety per cent. of a fatty acid called anacardic acid, and a little of an ammonium compound.

Cardol is an oily liquid of the spec. grav. 0·978 at 23° C., odorless at the ordinary temperature, but having a faint, pleasant odor when warmed. Its color, in mass, is a deep reddish-brown; in a thin layer, a beautiful brownish red. It is insoluble in water, readily soluble in alcohol and ether; it dissolves in concentrated sulphuric acid with a red color; also in strong potash lye, which solution becomes red when exposed to the air, and precipitates the salts of the earthy and heavy metals with a red or violet color. It burns with a bright, sooty flame.

Staedler proved by his experiments that neither the ammonium compound nor the anacardic acid were irritant; hence the vesicating principle must be cardol. To test the action of the oily substance contained in the pericarp, he spread it over about one square inch of the surface of the breast, and covered it with a piece of blotting paper also moistened with it. In the course of fifteen minutes a slight burning was perceptible, which rapidly increased and attained its greatest energy in half an hour. The skin beneath the paper had become whitish, surrounded by a red circle. The paper was allowed to remain in contact with the skin for three hours, which was then covered with small vesicles that increased in size during the night, without, however, attaining the size of those usually produced by cantharides.

The spot was dressed with linen, spread with tallow; it not only healed very slowly, but the after-effects continued for a long time; a second experiment made with the liquid which had been treated with dilute hydrochloric acid afforded the same result.

Henry W. Worthington states that he could fully corroborate the statements of writers concerning the irritant properties of the oily substance contained in the shell of the cashew nut, having suffered seriously from its effects while extracting it from the bruised nuts by ether and subsequent evaporation.

The U. S. Dispensatory notes a case of a lady who was exposed to the fumes of the nuts while roasting. Her face was so swollen that not a feature was discernible for several days.

A similar case occurred in a boy who cut open one of the nuts, eating a small portion raw, and, by handling it, spread the juice over different parts of the body. The tongue, face, neck, hands, forearms, etc., were enormously swollen, red, and very painful.

Several years ago, the writer and her husband, being ignorant of the poisonous qualities of the nut, incautiously attempted to break the shell with their teeth. Both suffered seriously from an obstinate eruption, accompanied with swelling and intense itching. In the writer, the eruption appeared in irregular patches on various parts of the body, while that of her husband was confined almost entirely to the anterior surface of the chest, the swelling being uniform and brawny, throwing the integument into four dense and prominent folds.

While conducting the necessary experiments for the extraction of the vesicating principle, the writer has again suffered from its poisonous effects.

While manipulating the nuts, the hands were incased in rubber gloves, and instruments used.

In spite of these precautions, a small particle of the juice was spattered on the right cheek just over the malar prominence. Instantly a slight burning was felt. As quickly as possible the poison was washed away with water, and to prevent any minute particle from adhering, again washed with ether.

At the point of contact a red line soon appeared, which had disappeared by the next day, and it was hoped that all unpleasant consequences had been escaped. The third day, however, a red line again appeared, which soon increased in a diffuse redness and swelling of the right side of the face. At first glance, the skin appeared red, œdematous, and smooth; but, by closer inspection, minute vesicles were discernible, which increased in size and number, until the surface was completely covered with them.

Hoping to limit its action to the part already affected, every precaution was taken to prevent conveying the virus by the contact of hands or towels. The inflammation gradually extended to the left side until the whole face and ears were involved.

The swelling was tense and brawny, so disfiguring the face as to render it unrecognizable to the most intimate friends. The dorsal surface of both hands, including all the fingers, became seriously inflamed, swollen, and covered with the characteristic œdematous eruption. The palmar surface escaped with the exception of a few scattered vesicles which appeared under the denser cuticle. Small patches also appeared on other parts of the body. The disease reached its height the eleventh day; the vesicles gradually diminished in size, and the skin assumed the appearance of the desquamative stage of eczema.

The treatment adopted was various and necessarily empirical, as no authorized line of treatment could be found. During the acute inflammatory stage, bathing with cold water and dusting with dry powder was all that gave the slightest relief.

Ammonia water, borax water, Goulard's solution, iodized glycerin, carbolated cosmoline, lime liniment, rose water ointment, oxide of zinc ointment, were used in the vain endeavor to obtain relief from the painful itching or to hasten the cure.

All oily substances produced such intolerable itching and smarting that they could not be endured on the face, but the zinc ointment gave great comfort to the hands.

Much of the treatment in the first attack is unknown to me; but I remember that oxide of zinc ointment gave the most relief.

Painting with tincture of iodine is suggested by Dr. Monkur in the New Jersey *Medical Reporter*, 1855, as an abortive treatment. This was faithfully applied to my hands, but without any apparent effect. Having suffered so severely from the action of this poisonous nut, a few words in criticism of its reputed uses may not be unwarranted.

Several authors speak of its use for the removal of corns, warts, and callosities, and some as a vesicant instead of cantharides. Considering the almost infinitesimal quantity of the poison which could have been absorbed in my recent attack, and the gravity of the results, it would seem, in my judgment, to be unwarranted to apply a remedy so uncontrollable in cases where many other standard remedies might be used which are not open to such objections.

*From a Thesis on *Anacardium Occidentale*, presented to the Massachusetts College of Pharmacy, 1878. Reprinted from *New Remedies*, February, 1882.

CARBOLIC ACID FOR BOILS, ULCERS, POISONOUS BITES, HEMORRHOIDS, CARBUNCLES, AND TUMORS.*

By N. B. KENNEDY, M.D., of Hillsboro, Texas.

MR. PRESIDENT AND GENTLEMEN: I wish to offer for your consideration on this occasion some of the conclusions I have arrived at, during a period of three years, in the administration, hypodermically, of carbolic acid, for the cure and removal of ulcers, poisonous bites, carbuncles, and tumors.

Carbolic acid, as you all know, is a solid, obtained from the products of the distillation of coal tar between a temperature of 300 and 400 degrees. It was discovered by Runge in 1834, who gave it the name of carbolic acid; but to Dr. Calvert is due the credit of introducing it into general use in the United States and England.

Carbolic acid may be defined to be an antiseptic anæsthetic, with slight caustic properties, and one of the most powerful disinfectants known. It has a very feeble claim to be recognized as an acid, being more closely allied to alcohol than acids, and, in consequence, is sometimes called phenylic alcohol. Carbolic acid has the power of preventing putrefaction in animal substances, arrests fermentation, and coagulates albumen. Carbolic acid in the liquid form is very slightly irritant; and when applied undiluted to the skin causes it to turn white, but produces very little pain. In contact with mucous surfaces it acts in the same manner.

When I commenced, three years ago, experimenting with carbolic acid hypodermically, it was with a firm belief that I would succeed. The experiments then commenced have ceased to be experiments, but have become established facts. I beg your indulgence while I rehearse to you, in as concise a manner as possible, some of the few out of many successful cases treated hypodermically and locally with carbolic acid.

CASE 1.—Mrs. McC., a delicate little woman, I found suffering with hemorrhoids nearly as large as a goose egg. I injected, hypodermically, five or six drops of Calvert's undiluted carbolic acid into the center of the tumor. The pain was but momentary, the anæsthetic effects of the acid following immediately on withdrawal of the needle. Four more injections effected a complete cure in this case.

CASE 2.—I was called, August 19, 1878, to see J. R. D., one of our most esteemed citizens, suffering with fifteen large carbuncles on his back and neck. He was suffering fearful agony, his family informing me he had not slept five minutes in five days and nights. I at once injected four or five drops of carbolic acid into each of the carbuncles, with the happiest effects. In five minutes the old gentleman was in a sound and refreshing sleep, which continued without intermission from 4 o'clock P.M. until 9 o'clock A.M. He awoke from sleep greatly refreshed and without pain, and never did have any more pain. Twelve of the carbuncles aborted and three went on to suppuration, or, rather, had commenced to suppurate when I first saw them. A complete cure followed in three weeks.

CASE 3.—Was called in the evening to see a boy, ten years old, who had been bitten in the morning by a mountain rattlesnake in the *dorsum* of the foot. On arrival I found the little fellow suffering terribly, with the foot and leg livid and much swollen. I immediately injected five or six drops of the acid, as near into the bite as I could. The relief from pain was so immediate that the little fellow asked me to let him see the "little thing" that stopped his pain so quick. The swelling rapidly disappeared, and he never suffered another moment's pain.

CASE 4.—J. L. F., a well-to-do farmer, consulted me about a tumor on the back of his neck, which had commenced to grow and was paining him. I found a fibrocellular tumor about the size of a small egg, and injected about twenty drops of undiluted acid into the center of the tumor, which in this case suppurated, but in a week or ten days had entirely disappeared, and left no cicatrix behind.

CASE 5.—My friend, Dr. Carmichael, of Peoria, Hill Co., Texas, invited me to see Miss J. A., a young lady, eighteen years old, in the full bloom of womanhood and beauty, for my opinion in reference to a very large tumor in her right breast. Her history was good; she had been in good health all her life. Two years since the *catamenia* was established, synchronous with which she noticed a swelling in the right breast. It had been growing for two years, and was now as large as a child's head. She had never suffered any pain in the gland. I diagnosed it to be a multilocular adenoid tumor. I injected about twenty drops of pure, undiluted acid into the most prominent portion of the tumor. The pain was very slight, the anæsthetic effects following immediately the withdrawal of the needle. I used the remedy once a week, from week to week, for two months, at the expiration of which time the tumor had decreased in size from that of a child's head to that of a goose's egg. I now commenced to use the remedy twice a week, and at this writing the tumor is about as large as a hen's egg, and the indications are favorable for its entire eradication. (NOTE.—In a month after this paper was read the tumor had entirely disappeared.)

I also use carbolic acid locally with the happiest effects. I was called to see the Rev. Mr. B.'s wife, who had been confined to her room and bed for two years, and had had various treatments, both from regular and irregular physicians, with but little benefit. An examination, per vaginam, revealed a fully ulcerated os and cervix uteri, with an exceedingly offensive discharge and smell from the genitalia. I applied a fifty per cent. solution of the acid to the ulcers three times per week, and directed for her a good alterative tonic; and in three months she was the very picture of health.

A highly nervous young lady came to my residence to have a felon lanced, and was clamorous for chloroform, as she feared the pain would kill her. I bathed her finger in pure, undiluted acid, and lanced the felon almost without pain, much to her astonishment.

In conclusion, then, allow me to advance the opinion that in carbolic acid we have one of the most powerful remedies for good in the whole pharmacopœia, and one at no distant day destined to supersede almost all other medical and surgical procedure. An antiseptic and anæsthetic disinfectant, *facile princeps*, in surgical cases.—*Med. and Surg. Reporter.*

* Read before the Texas Medical Association, at its session in the city of Waco, Texas.

HYPOTHETICAL HIGH TIDES, AS AGENTS OF GEOLOGICAL CHANGE.*

By DR. J. S. NEWBERRY.

PROF. ROBERT BALL, of Dublin, has recently delivered a novel and interesting lecture with the poetical title, "A Glimpse Through the Corridors of Time," in which he advances a theory in regard to the agency of the tides in producing changes on the earth's surface, which is so discordant with the facts observed and the conclusions adopted by geologists, that it would seem to call for some notice from them.

In this lecture the views of Mr. George Darwin, in regard to the history of our telluric system, are accepted, and it is claimed that the moon was at one time a part of the earth, but that while the latter was imperfectly consolidated, it was thrown off by the preponderance of the centrifugal over the centripetal force. After the separation, according to Prof. Ball, the earth and moon revolved simultaneously around a common axis once in three hours. Since that time the moon has been gradually receding and lagging behind in its rotation, until it is now 240,000 miles away, and revolves but once, while the earth makes twenty-seven revolutions of twenty four hours each.

The special purpose of the lecture was the announcement of the discovery of a new agency in geological change, and one represented to be of transcendent power, viz., ancient high tides. At the present time, with the moon 240,000 miles distant, its attraction produces a tide reaching sometimes, as in the Bay of Fundy, a height of sixty feet—a tide which, in its ebb and flow, causes a considerable amount of change in the land, washing away banks and cliffs, and transporting to sea great quantities of detrital matter.

Prof. Ball asserts that at certain times in the recession of the moon from the earth, and after the cooling of the globe had produced the precipitation and accumulation of ocean waters, the attraction of the moon acting inversely as the cube of the distance, produced tides of stupendous altitude as compared with any now witnessed. For example: supposing the earth to have been largely covered with water, when the moon was 40 000 miles away, one-sixth of its present distance, its attraction must have been thirty-six times as great as at present, and its efficiency as a tide-producer two hundred and sixteen times as great as at present. This would give, for an average tide corresponding to a tide of three feet now, a height of 648 feet.

Prof. Ball pictures to his audience the effect of a tidal wave of this height rushing over and retreating from all shores twice in each short day, and justly ascribes enormous destructive power to such an agent. This condition of things he fancies to have existed forty or fifty millions of years ago, perhaps when the first sedimentary rocks now known, the old Palæozoic and Archæan strata, were deposited; and since in certain localities there were accumulations of mechanical sediments, shales, sandstones, etc., to the depth of several miles in these ages, they are explained to be the result of the action of these tremendous tides.

Prof. Ball further ascribes to this agent the greater part of the changes that have taken place on the earth's surface, and claims to have revealed to geologists in this discovery the most important factor in all their data for writing the ancient history of the globe, and one of which they seem to have been strangely ignorant.

Now, all this is exceedingly interesting and important, *if true;* but in behalf of the geologists I venture to report certain facts which seem to be quite irreconcilable with it. There can be no question that a tide of 600 to 1,000 feet in height, sweeping over all shores and lowlands twice a day, would be a most powerful, destructive, and creative engine; and it may be conceded at once that its potency in remodeling the earth's surface would far surpass any agent of change now in action.

Let us imagine for a moment what the effect of a tide two hundred times greater than the present would be, if called into existence on the Atlantic coast of America to-day. The height of the tide along our coast varies from nine to twelve feet, and we may say the average is ten. This would give a height of two thousand feet to the tide produced by the moon if only 40,000 miles distant. The effect of such a flood would be so tremendous that it can hardly be realized. The whole littoral plain, two hundred miles wide, which forms the topographical margin of the continent, now half sub-marine, half sub-aerial, would be swept twice a day with a wave not less than a thousand feet in height; and a bore fifty times as high as that of the Hoogly would rush up the Hudson and Mohawk, and sweep the valley of the Mississippi to the basin of the Great Lakes. Rocks would be torn from their beds, and with all loose material, bowlders, gravel, sand, and clay, would be swept to and fro with overwhelming violence, and finally be spread far out over the bottom of the adjacent ocean. All this broad littoral zone, now crowded with life, and the scene of greater vital activity than any other equal area above or below the ocean level, would become at once a howling wilderness, where nature's forces waged perpetual war, and life would be impossible.

So on all other shores the physical and vital changes would be immeasurable. Erosion would be carried on with such energy that soon all continents would be worn away, all mountains be transported into the sea. All coral reefs, all sea-weeds, and indeed nine-tenths of all the life on the globe, would, however, be swept out of existence before that time. Half the land of the globe would be submerged and desolated, and, with the destruction of the marine and the restriction to narrow limits of terrestrial vegetation, the pabulum of animal life would be so much reduced that the globe would be practically depopulated.

It may also be said that if, as we suppose, the precipitation of ocean waters took place before the corrugations of the earth's surface had assumed any considerable magnitude, and it was nearly or quite covered with water, tidal waves 500 feet or more in height, sweeping over the globe in rapid succession, would have worn away the emerging land as fast as it appeared, would have prevented the formation of continents and have precluded the existence of land animals or plants.

From these facts it will be seen that if such tides had been at any time in existence on the earth's surface, traces of their action would be universal and indisputable.

Having studied with some care the geological record in places where it is as nearly complete as anywhere, I must say that I not only fail to find any proof of the existence of these stupendous tides pictured to the imagination by Prof. Ball, but, on the contrary, the whole of that record, from the Archæan to the Tertiary, offers abundant and conclusive evidence against such a theory.

As to what took place before the deposition of the Laurentian strata, we can have no knowledge, because they are the oldest known rocks; yet the era of their deposition can hardly have been less than twenty or thirty millions of years ago. Though much changed from their original condition as aqueous sediments, we are yet able to recognize in them the prototypes of the sandstones, shales, and limestones of later formations, and we may fairly conclude that they were deposited under like conditions. In the gneiss and granite of the Laurentian we have representatives of the coarser sediments formed along shores; the slates are the clays of ancient times, the deposits of quiet waters off-shore; while the marbles, which in some places form a considerable portion of the Laurentian series, are undoubtedly organic sediments that accumulated in relatively deep and quiet water by the slow process of growth and decay of animal structures. Thus the slates and the limestones are records of long continuance of quiet times and the absence of great high tides. Even the gneisses and granites are strata which must have been very different from such as would be formed by the impetuous rush to and fro, over the ocean's shores, of a semi-diurnal wave hundreds of feet in height.

The Huronian series, which follows the Laurentian, consists mainly of slates, sometimes beautifully ripple-marked, and of beds of iron ore—all shore and shallow-water deposits, but speaking of quiet times and no high tides.

The Cambrian rocks are but imperfectly shown on this continent, but they are all fine mechanical sediments, or earthy limestones, often fossiliferous, deposited along the Laurentian shore, but with an absence of all coarse material and cross-bedding, such as would be produced by rapid currents or violent ebbs and flows.

In the Silurian series, which is here remarkably complete, we have a record that tells with great clearness the physical, as well as the vital, history of the continent at that age. The Potsdam sandstone is an old beach spread over large areas of pre-existent land by a slow and quiet subsidence and an invasion of the Lower Silurian sea. The Laurentian highlands, the Adirondacks, etc., formed the shores of that sea, and the Silurian rocks were deposited in it. We know with considerable accuracy the boundaries of this sea, and can trace its shore-line for a thousand miles as easily as we can that of the present Atlantic coast, and can study the littoral phenomena as satisfactorily. On the old beach, as on the new, gentle zephyrs covered the shelving bottom with ripple-marks; the stems and fronds of sea-weeds are in places thickly interlaced, the beach-loving brachiopods strewed the shore with their whole or broken shell, and the boring annelids pierced the sand with innumerable holes. This automatic and indisputable record is so clear and simple that a child may read it, and it tells in unmistakable language that in the beginning of the Lower Silurian age the littoral conditions were essentially the same as now, and that no high tides, such as we have been considering, could possibly have swept these shores.

Above the Potsdam sandstone is spread a sheet of organic sediments—the great Trenton limestone group—in places a thousand feet thick, composed almost entirely of the hard parts of animals which inhabited the sea. These accumulated slowly age after age, in water so quiet that the most delicate marine organisms are beautifully preserved. In places the Trenton limestones abut directly against the Laurentian cliffs which formed the shore, and which suffered so little wear that they contributed scarcely anything to the organic sediment deposited at their base. This record hardly requires translation to be understood by all, and its antagonism to the proposed theory is apparent and irreconcilable.

Toward the close of the Lower Silurian age, the sea slowly retreated from the land it had before invaded, forming wide areas of shallow water, in which grew countless numbers of sea-weeds and delicate graptolites, the carbonaceous matter of which, mingling with a fine wash from the land, produced the bituminous clays which we now call the Utica slate. It is evident that the organisms which supplied the combustible matter of this deposit could only have lived in quiet lagoon-like bays, and their presence and product, with the fineness of the inorganic sediment, are incompatible with Prof. Ball's theory.

Similar phenomena teach the same lesson in the records of the Devonian, Carboniferous, and later geological ages. In the Devonian rocks we have another and apparently conclusive argument against extraordinarily high tides, for here are coral reefs, rivaling in extent those of the tropics at the present day. Now, unless the reef-building polyps were formerly altogether different in habit from those now living, these coral reefs must have been formed in water not exceeding two hundred feet of average depth and not subject to great oscillations of level. High tides would now effect the rapid destruction of the whole race of reef-building animals; at the ebb, exposing them to the air and sun for hours, and at the flood, burying them too deeply for their continued existence.

The abundant sea-weeds buried in the rocks of the Palæozoic and later ages offer an equally strong argument against the high-tide theory. Nearly all the sea-weeds now living in our oceans occupy the immediate shore, and chiefly grow within a depth of from 50 to 100 feet from high-water mark. It is easy to see that if the present oceans were affected by a movement like that described by Prof. Ball, the zone the sea-weeds occupy would be the scene of the greatest mechanical violence, and they would be alternately left to dry in the sun, or be torn with resistless force from their anchorage and scattered over the land washed by the flood-tide. On every old beach, however, of which we find so many in the geological series, the casts of the fronds and stems of sea-weeds are as plainly discernible as on our present shores.

In view of these facts, and others of similar import which might be cited, we are compelled to reject this theory of high tides, at least for the interval which separates us from the beginning of the Laurentian age; in other words, for the entire reach of geological history; and we are compelled to infer that either the astronomers are mistaken in their views of the genesis of the moon, and that she never formed part of the earth's mass, or that her separation and recession to near her present distance took place before the beginning of geological history. Certainly so much of the geological record as is now submitted to our inspection, offers no evidence in confirmation of, but much that is diametrically opposed to, this high-tide speculation.

* A paper read before the New York Academy of Sciences, January, 1882.

EXPLOSIVE WAVE.—The author holds that his recent experiments on the propagation of explosive phenomena in gases reveal the existence of a new kind of undulatory movements of a mixed order, produced by a certain concordance of physical and of chemical impulses within matter which is undergoing transformation. The speed of the explosive wave is totally different from that of sound waves propagated in the same medium.—*M. Berthelot.*

A GEOLOGICAL BROKER.

"I HAVE walked up town after business hours for ten years," said a member of the Mining Exchange, "and find it always interesting. I generally take Broadway from some new point of view every day. One day I study character. I know all the confidence men by sight as well as the Broadway statues, and it is amusing to pick out strangers in the city and see what they are interested in. Another day I count the Jewish names on the signs of dry goods houses between Chambers and Fourteenth streets. Their number would astonish you. Then there is the study of the signs themselves. Some show the greatest artistic merit, and are really worth looking at. And here, now, is something to start a train of thought that will last all the way up Broadway."

As he spoke he stepped into the Post-Office and pointed to a number of curious marks on the square-blocked floor, which looked as if some one had pounded a coiled clock-spring against the stone.

"Now," he continued, "you, and nine men out of ten, have probably noticed these curious marks on the floor, and thought, perhaps, they were made by some one turning on his heels rapidly. That is just where you are mistaken. Just examine it closely. Don't mind the people. They'll think you have dropped a stamp."

Stooping, his companion found that the coiled outline went below the surface, and that delicate radiations went out from it.

"You see," continued the rock sharp, "it is a shell, and right here in the Post-Office you are standing on sections cut from an old beach upon which the sea beat tens of millions of years ago. These are shells that were washed ashore or tossed upon the sand. The sand in time became hardened, and the contractor of the New York Post Office took possession and polished up the old beach, and here we have it shells and all. This stone belongs to what is called the Hamilton beds, from which most of our flagging comes. When these shells were alive all New York State was the bed of a great shallow sea that spread away to the lakes. When the water shoaled there were great mud flats. From the nature of these shells we know it was salt water, and from the fact that the living allied forms of this coiled shell are peculiar to the south, we may assume that the climate of New York then was something like that of Florida now. It is pretty hard to get men to believe that, but it's a fact."

They crossed Broadway, and joined the tide that swept up town.

"Now, these paving-stones," said the naturalist, casting a look at them as if each was an old friend, "they are old-timers, and reach way back into the past so far that it tires one to think of it. They were probably formed by the first cooling of the crust of the earth, and belong to the azoic rocks, or the rocks of the time when there was no life on the earth. These rocks are all crystalline and are universal—that is, they cover the entire globe and form the foundation upon which the later, and, we will say, animal-bearing layers rest; only here and there they crop out so that we can quarry them. The azoic rocks are interesting, too, from the fact that in this State they contain a great quantity of iron ore. These great slabs that we are walking on are Hamilton again. Stepping from the paving-stones to the sidewalk, we cover a lapse of time only to be counted by millions of decades. A great number of these flags are taken out from quarries near Kingston, Saugerties, Coxsackie, and in various parts of Ulster, Greene, and Albany counties. The slabs are extremely free from fossils, except the tracks of worms, but almost every block will show a shell, a bit of a crinoid, or something that tells the story. How many people, now, do you suppose appreciate their privileges as they walk up town? Think of having an ancient beach, with all its shells, laid out in a line for fifteen miles for you to walk upon! What are the unearthings of Pompeii to this? One is yesterday; the other so far back that the mind cannot appreciate it. These Hamilton rocks, that are mostly the sediment of the ancient sea, are in New York State over one thousand feet thick. On some of the flags as they come out you can see the ripple marks left by the last tide that ran over them, and even rain drops that have been perpetuated into all time. Some of the shells, such as the spirifers, are extremely beautiful. The nautilus-like shells in the Post Office floor are distant cousins of the cuttle fishes of to-day, with their pedigree stamped in stone. Corals are found in the Hamilton flags, and on some of the latter I have seen crinoid stems so thick that there must have been a forest of them that were suddenly killed by some convulsion.

"Here's the new red sandstone," he continued, as they passed a brown-stone building near Astor place; "all the brown-stone fronts are taken from old beaches in Connecticut, and belong, probably, to the triassic period of the geologist. If you had lived in Connecticut or Massachusetts about the time these brown-stone fronts were deposited, you would have seen Mount Tom and Mount Holyoke rise into their present shape, as the trap rock that formed them oozed through the crusts of the earth at this time, and hardened or cooled into the present mountains. East and West Rock, near New Haven; the Hanging Hills, near Meriden; our Palisades, up the Hudson, and Bergen Hill, were all formed in the same way and at about the same time.

"The Connecticut River flows in a part of its course through the brown-stone beds that rest conformably on the edges of primary rocks. The quarries near the river have been worked for many years. One day Dr. Deane, of Greenfield, was watching the men taking out the blocks, when he saw upon the face of a piece of shale an impression that looked like an enormous bird's footprint. He secured it, and spoke to Prof. Hitchcock, then President of Amherst College, about it. Together they investigated the matter, and to them is due the credit of establishing upon scientific grounds the fact that wondrous bird-like reptiles existed in New England, and that these were their tracks. Some are enormous, much larger than the feet of the giant moas of New Zealand. One track was traced by Prof. Hitchcock into a hill, where the deposit over it was over a thousand feet in height, which gives a good idea of the time that has elapsed since the animal went walking there. Most of the finest specimens obtained from the quarries at Portland, Conn., were placed in Amherst College, amounting in all to over twenty thousand distinct gigantic footprints. By carefully examining the country, maps have been made showing where the coast line was at this time. Supposing people to have lived then, they could have sailed up Long Island Sound, passing through an arm of the ocean that extended up the Connecticut valley and into New Hampshire. On these shores, as the tide went out, the gigantic creatures left their hiding places and crawled about. Every mark they made was quickly hardened by the tropical sun, and when

the tide came in the first gentle ripple that licked the heated flat filled up the tracks with soft layers of sediment. This was repeated as tide after tide came and went, and now as we take in hand a section of the beach and tap it upon the side, it separates into strata, each sheet, as we might say, representing a tide, and on one layer we have the impression and on the opposite its cast, as perfectly preserved, to speak without flattering nature, as if made by man. Besides the great bird tracks, many made by insects are found; and if you take a fly, dip its feet in some colored liquid, and allow it to walk over a piece of white paper, you can get a very good idea of some of these old tracks on the rocks. Many of the marks were also made by fishes as they crawled along in the same fashion as do some of the shore fishes of our time, while others show the marks of the fins of a fish as they struck ripple marks made by some previous tide. Strange crab-like animals were found upon this ancient shore, and the tracks of one have been found straddling over eighty feet. It was probably perched on legs very long that supported the animal high in air.

"So much for Broadway rocks; and if we should keep on up through Central Park, we could see rocks that bear the marks of glaciers that at one time were piled over this State hundreds of feet thick. The great mass that juts out over the road just beyond McComb's Dam shows how the stratified rocks have been pushed up and doubled and bent as if they were paper. You can count with the point of your knife every layer, each one a leaf in the history of the world.

"But here we are at the end of my walk," concluded the naturalist, and with a farewell salutation he disappeared behind brown-stone walls from the old triassic beach.—*N. Y. Sun.*

GALEANDRA NIVALIS.

THIS beautiful and rare orchid was shown at the meeting of the Royal Horticultural Society, on March 18, by Sir Trevor Lawrence. The galeandras are tropical American orchids, with slender erect fleshy jointed stems, the joints swollen, glaucous; the two-ranked sheathing leaves are narrow lanceolate. From the apex of the stem proceeds a nodding raceme of flowers, each about two inches in length, with narrow reflexed rich olive-colored segments, with a large funnel shaped white lip, marked with a central violet blotch. It is a species demanding a high temperature and abundance of moisture during the growing season.—*Gardeners' Chronicle.*

GALEANDRA NIVALIS.

ON THE COMPOSITION OF AMERICAN GRASSES.

By CLIFFORD RICHARDSON.

[ABSTRACT.]

THE large number of analyses of grasses which have been made during the last few years in the laboratory of the Department of Agriculture make it possible to deduce certain averages for their composition which are of great interest, both in comparison with those of Wolff for German grasses, and as showing the relations of cultivated and wild grasses toward each other, and the variations in composition which one species may present when grown on different soils and in different climates.

In the following table are presented the figures which I have obtained:

It is plainly shown that all our American grasses are strikingly different in composition from similar German varieties. In the first place, the content of nitrogen is smaller, accompanied by a largely decreased amount of fiber. In the next place, these changes are made up by a larger amount of nitrogen free extract and a slight increase in fat. The nutritive ratio, then, is much wider than in the German grasses.

Considering the relations of the different kinds of American grasses to each other, it is apparent that the wild varieties are, as would be expected, of much less nutritive value than those which have been cultivated. The average composition of orchard grass is not equal to that of the better cultivated varieties; and among the latter the higher the cultivation the better the quality, as is shown by the averages for the grasses grown in Pennsylvania, which had not been as highly fertilized as those from the grounds of the Department of Agriculture in Washington. The explanation of the differences between American and German grasses may be that the latter have been under cultivation so much longer that they have improved in quality; or rather, perhaps, that they grow on more highly fertilized soils, from which they are able to assimilate larger amounts of nitrogen, the grasses, as is well known, being quite dependent on the soil for that element, while they are, owing to their larger content of fiber, perhaps of less real value than the American species. In this connection it would be most interesting to study the effect of different fertilizers on our native and cultivated species, and such a course of experiment I intend to carry out in the near future. Another prominent fact which is shown by the table is, that in the wild grasses the amount of nitrogen in the non albuminoid form is larger than in the better varieties, and that the amount varies somewhat as the quality of the grass, the more highly cultivated varieties from the grounds of the Agricultural Department having only a little more than half as much as is found in the wild species. The character of the soils upon which the specimens grew which I have analyzed may have had some influence upon the results, outside of the amount of cultivation to which they were subjected. The wild grasses were for the greater part from the sandy soils of the South; those from Pennsylvania grew upon a micaceous loam, and the soil of the grounds of the Department of Agriculture is of a heavy nature, as indicated by an analysis in the report for 1879, p. 93.—*Am. Chem. Jour.*

TABLE.

AVERAGE COMPOSITION OF GRASSES IN BLOOM.

	AMERICAN.				GERMAN.		
	77 Analyses of Wild Grass.	21 Analyses of Grasses from one farm in Penn.	19 Analyses of Grasses from Dept. Grounds.	6 Analyses of Orchard Grass from Various Localities.	Wolff's Averages.		
					Fair.	Good.	Very Good.
Ash	7·90	7·05	7·44	7·38	6·30	7 23	8·24
Fat	2 90	3·12	3·52	3 33	2·34	2 92	3·29
N free extract	53·90	55·75	55·82	55·17	46·53	47·84	48·93
Crude fiber	27 10	23 14	22·47	25·19	34·09	30·69	25·77
Nitrogen × 6.25	8·20	10 04	10·25	8·91	10·74	11·32	13·77
P. c. N as non-alb.	34·7	30·1	18·3	25 2	..	..	..
Nutritive ratio	1 : 10·2	1 : 8 1	1 : 8·0	1 : 9·4	1 : 7·7	1 : 7·2	1 : 5·7

THE POPLAR.

THIS tree is called whitewood and yellow poplar, from the color of its timber; canoe-wood, from the use made of it by the native Indians, and saddle tree, from the form of its leaves. In Britain it is called virgin poplar, tulip-bearing lily tree, and saddle tree. In Kentucky and Tennessee it has the name whitewood and yellow poplar. In other parts of the United States it has been called the tulip tree, and the curious name of old-wife's-shirt tree. It is the tulip bearing *Liriodendron* of North America.

The poplar attains the greatest dimensions of all the indigenous deciduous trees of North America. With its perfect straightness, uniform diameter of trunk, regular distribution of branches, richness of foliage and flowers, it stands unrivaled, the most magnificent production of the temperate zones. It usually reaches a height of 60 or 80 feet, with a diameter varying from 18 inches to 8 feet, and in favorable localities it has been found rising to the height of 120 to 140 feet, with a diameter of more than 7 feet. In 1842 a tree was felled on the estate of Mr. John Lewis, in Llangollan, Ky., which measured 3 feet in diameter, near the ground, and 5 feet at 75 feet from the ground. The trunk was perfectly straight. In 1807 there was a tree in Hamilton, Adams county, Penn., which had a circumference of 36 feet, with trunk rising 30 or 40 feet to the forks. It is well authenticated that near the head of the Roanoke River there was a tree 39 feet in circumference at a distance of 4 feet from the ground, and it was a distance of 40 feet to the forks. The bark of the trunk, while the tree is small, is smooth and even; when it exceeds seven or eight inches in diameter it begins to crack, and presents furrows, which increase in depth in proportion to the age of the tree.

The leaves are smooth, truncate at the top, four-lobed, and saddle shaped. They differ in development from those of most other trees. The leaf buds are composed of scales, closely imbricated, which in spring are distended by the growth of the minute bundle of leaves that they inclose, till they finally fall off. The terminal bud of each shoot enlarges and gives birth to the leaf. It forms an oval envelope, containing the young leaf, which is produced to the light as soon as sufficient strength has been acquired for it to endure the effects of the atmosphere. Within this envelope is found another, which repeats the process of the initial leaf, and in young and vigorous trees five or six leaves issue in turn from one bud. The growth of the leaves is very rapid. They are six or eight inches long, borne on long petioles, alternate, somewhat fleshy, smooth, and of a beautiful green color. In Carolina and Georgia the flowers appear in April and May, and in the northern parts of the United States in June and July. The flowers are large, solitary, terminal, variegated with green, yellow, and orange, the yellow predominating. Surrounded by luxuriant foliage and emitting an agreeable odor they produce a fine effect.

The fruit is composed of numerous thin, narrow scales, attached to a common axis, and forming a conical spike two or three inches in length. Each spike, or fruit, contains 60 or 70 carpels, of which never more than a third and in some seasons not more than seven or eight in the whole number are productive. It has also been noticed that during ten years after it begins to yield fruit nearly all the seeds prove non-germinal, and that on large trees the seeds from the highest branches are best.

There are three varieties which may be regarded as distinct from the species of this tree: the blunt-leafed, differing only in the form of the leaves; acute-leafed, having smaller leaves; and the yellow-flowered, which is very rare.

The natural distribution of the poplar embraces a large part of the area of the United States. It is found in its natural state at the southern extremity of Lake Champlain, along the Connecticut River, reaching no further north or east than these localities, and apparently avoiding the sea coast, as it is not found indigenous in the eastern portions of the Atlantic States, or the southern portion of the States bordering on the Gulf of Mexico. It is multiplied in the Middle States, in the upper parts of the Carolinas and Georgia, and becomes still more abundant in the Western States, particularly in Kentucky, where it displays its greatest productfulness and most perfect development. It delights only in deep, loamy, and extremely fertile soils, such as are found in the rich bottoms along rivers, and on the borders of the great swamps occupied by forests. Its comparative rareness in maritime regions is due to the thin and dry soil, and to the excessive wetness of the swamps of the rivers. It is usually found mingled with other trees, such as hickories, black walnut, wild cherry, and butternut, although at some places it alone constitutes considerable tracts of a forest.

Like the most of trees it will grow on soils of different qualities, the tree and its qualities clearly showing the effect of the surrounding circumstances. It has been introduced into Europe, and will variedly flourish in all parts not too far north. In dry, gravelly soil, and in exposed places, the dwarfing effects are plainly seen. It will not thrive even where there is a subsoil of clay. The introduction to England is said to have been made by the Earl of Norfolk, as far back as 1673. Now, it may be found in Germany, Italy, and France, in their gardens and along avenues, where it is prized for its umbrageous magnificence. The most favorable situation is where it is sheltered from high winds, with sufficient exposure to light and air to admit of the maturation of its leaves on every side, and the perfect ripening of the wood to enable it to resist the frosts of winter. The oldest tree in England is estimated to be 150 years of age. It is at Fulham Palace, and is 50 feet high. The largest specimen is at Hestercombe, it being 100 feet in height, and three feet in diameter. Some have attained a large size at Vienna, but none will grow north of Warsaw or Moscow without careful protection. At Schwobber, near Hanover, there is a tree, in rich soil, over 120 years old, which is 80 feet high and 30 feet in circumference. Seventy or 80 feet in height is attained in Italy. There is an account in history of the Empress Josephine's gardener attempting to gather seeds from a poplar at Lacken, near Brussels, and how he fell and broke his neck. It is successfully cultivated along our coast, from Newburyport, Mass., to St. Mary's, in Georgia.

The tree is propagated from the seeds, which are planted in the autumn and come up in the spring. As the roots are scanty in extending fibers, it does not admit of ready transplanting.

The timber is compact and fine grained, with qualities rendering it easily polished. A cubic foot, when dry, weighs 25 pounds. The heart, when perfectly seasoned, resists well the influence of the air, and is rarely attacked by insects. Its greatest defect, unless carefully and properly seasoned, is the liability to shrink and warp by the alternations of moisture and dryness. The nature of the soil has a marked influence on the color of the wood, which is distinguished by the names white and yellow poplar, although at the present time both varieties are known by the common name whitewood. The white grows upon the elevated places where the tree abounds, and may be recognized by the branchy summit. There is said to be some difference in the grain, but if so, it is too slight for consideration. In the early days of New York and Philadelphia this wood was extensively used in the construction of houses. It was used for rafters and joists in the upper stories, and was much esteemed for its lightness and strength. As the wood became scarce in the vicinity, pine very naturally took its place. In the Middle, Southern and Western States, where the tree grows abundantly, it has been, and still is, extensively used, and is considered a good substitute for pine, red cedar, and cypress, and serves well for the interior work of houses as well as for external covering. The panels of doors, wainscots, and mouldings of chimneys are

made of the wood, and shingles have been made in some States. These shingles are preferred by some to pine, because they are more durable and not liable to crack from the effects of intense frost and sunshine. Lumber sawed from this tree is used in all the principal cities for the panels of carriages. When perfectly dry, they take paint well and admit of a brilliant polish. It enters largely into coach manufacturing, and is used in cars, wagon boxes, sleighs, etc. The Studebaker Brothers Manufacturing Company, South Bend, Ind., contracted for 1,000,000 feet from one firm. It is particularly applicable to any work requiring soft wood easily worked, and not requiring great strength, especially if wide work is desirable. It was used years ago in large quantities in the manufacture of trunks, which were covered with cloth or skins. Large quantities of tables and bedsteads have been made from the wood. They are usually stained to imitate mahogany. It often enters into the construction of bureaus and general cabinet work, particularly where it is the base for covering with veneer. It has been used also in the interior work of canal boats and steamboats. As it is easily wrought in the lathe, it is often used for bowls, brush and broom handles, and numerous other articles of turned wares. Farmers construct eating and drinking troughs for their animals of the wood, as it stands long exposure to the weather better than chestnut or butternut. It is used also in bridges in some places. The Indians were wont to make canoes from the big trees, and some of them had room for twenty or more persons. In some parts of the country long lines of fences may be seen that are made of rails from this tree. One-third of the lumber used in making coffins in New York city is whitewood, it being used for the sides and tops. Very large quantities are consumed in the backs and legs of pianos. Furniture manufacturers use it for ebonizing, and in parts where great strength is not required. A manufacturer of bungs in New York uses 500,000 feet annually, and it is also used largely in the making of toys and pumps. It has been used to some extent for flooring, and quite extensively for mouldings and trimmings.

It is exported, but not extensively. Shipments are occasionally made of quantities of logs, sometimes reaching as high as 50 or 60. The shipment of lumber is rarely, if ever, made at the present time.

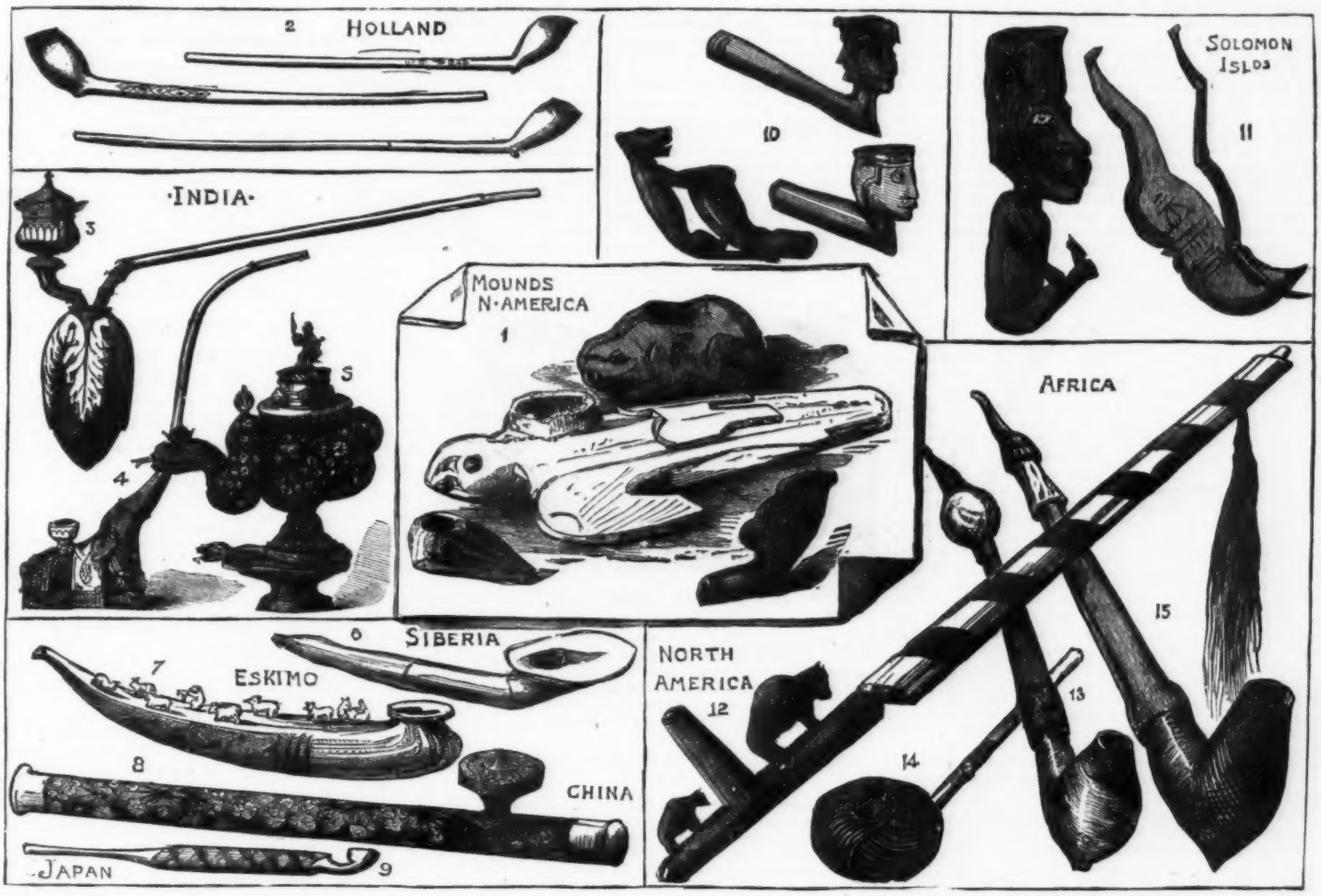
In consumption, whitewood stands next to pine, and there are over 50,000,000 feet annually used in New York. Where good pine uppers are quoted at $65, whitewood of the same grade is only $40. As a matter of economy many will therefore use it, especially where it will supply well the place of pine.

It is a good wood for the production of charcoal, yielding 22 per cent.

And yet after all its importance in architectural art, this is not all. The bark has been long used as a medicine, and is considered by some scarcely inferior to cinchona. It is a domestic remedy for the intermittent fever, the bark, with equal parts of dogwood bark, being steeped in brandy for some days, and the tincture or decoction thus prepared taken freely. The bark is reduced to a powder by some, and used as a vermifuge. It was a favorite remedy among the American Indians in intermittents.—*Bing. in N. W. Lumberman.*

THE PIPES OF ALL PEOPLES.

THE loan collection of objects connected with the use of tobacco and other narcotics, belonging to Mr William Bragge, F.S.A., F.G.S., of Birmingham, has cost thousands of pounds, and comprises above seven thousand specimens. This exhibition, which was at the Edinburgh Museum of Science and Art not long ago, and which may now be visited in London at 14 and 15 Castle street, Leicester square, is one of an instructive character, both as regarded from the technical or artistic, and from the ethnological point of view. It includes the pipes of many nations and different ages, French, German, Austrian, Dutch, Italian, Spanish, English, Swedish, Norwegian and Danish, Russian, Siberian, Turkish, Egyptian, Algerine and Moorish, West African, Kaffir, Australian and Polynesian, Persian, Indian, Chinese, Burmese, Malay, North American Indian, Mexican, and South American, with tobacco boxes and jars, pipe-stoppers, cigar-cases, and fire-strikers, snuff-boxes, rasps, mills, spoons, bottles, and other apparatus, not omitting the articles used in the consumption of opium and of betel-nut. The whole collection may be advantageously studied along with the perusal of such a treatise as Mr. F. W. Fairholt's "Tobacco: its History and Associations," and with the help of a special "Guide," which was compiled by Mr. C. N. Muston, of the Edinburgh Museum, and was published there by official authority. We have engraved a few drawings of a variety of specimens of "the Pipes of All Peoples."—*Illustrated London News.*



1. Stone and clay tobacco pipes, the most ancient in the world (prehistoric), from Ohio, Tennessee, Virginia, and Pennsylvania.
2. Earliest European tobacco pipes, Dutch, Sixteenth Century.
3. Indian, with silver-gilt fittings, the bowl a nut
4. Indian, the elephant of ebony, with gilt trappings.
5. Indian, the stand of green jade, the serpent of wood, silver fittings.
6. Siberian pipe, carved of mammoth ivory.
7. Eskimo pipe, carved of tooth of a cetacean.
8. Chinese opium pipe.
9. Japanese pipe.
10. North American Indian pipes.
11. Betel box and cutter from the Solomon Islands.
12. Calumet of Pawnee Indians, North America; the bowl carved of dark red stone, in the shapes of a bison cow and calf; the stem of painted wood, horse-hair plume.
13 and 15. Pipes from the Nile, Upper Egypt.
14. Kaffir snuff bottle, carved of hard wood.

PIPES OF ALL PEOPLES.

DR. MACGOWAN ON THE UTILIZATION OF ANTS AS GRUB DESTROYERS IN CHINA.

ACCOUNTS given of the depredations of the *coccids* on the orange trees of Florida induce me to publish a brief account of the employment by the Chinese of ants as insecticides. In many parts of the province of Canton, where, says a Chinese writer, cereals cannot be profitably cultivated, the land is devoted to the cultivation of orange trees, which, being subject to devastation from worms require to be protected in a peculiar manner, that is, by importing ants from neighboring hills for the destruction of the dreaded parasite. The orangeries themselves supply ants which prey upon the enemy of the orange, but not in sufficient numbers; and resort is had to hill-people, who throughout the summer and winter find the nests suspended from branches of bamboo, and various trees. There are two varieties of ants, red and yellow, whose nests resemble cotton bags. The "orange ant-breeders" are provided with pig or goat bladders which are baited inside with lard; the orifices of these they apply to the entrance of nests, when the ants enter the bags and become a marketable commodity at the orangeries. Orange trees are colonized by depositing the ants on their upper branches, and to enable them to pass from tree to tree all the trees of an orchard are connected by bamboo rods.

Is the orange the only plant thus susceptible of protection from parasitic pests? Are these the only species of ants that are capable of utilization as insecticides? Indubitably not, and certainly entomologists and agriculturists would do well to institute experiments with a view to further discovery in this line of research. Lest, however, the United States Entomological Commission or Société d'Acclimatation of France, should undertake to acclimatize these Cantonese formica, I must interpose a word of caution. There is found in the same province, in the part of which Swatow is the port, an ant that is a foe and not a friend of agriculture. It is called the "horse-ant," from its fancied equine appearance. Horse-ants are so destructive that a temple has been erected for the worship and propitiation of the Ant God, the producer and ancestor of ants. During the fifth month of every year the ants assemble to pay court to their progenitor, which is the season when farming people present offerings to the Ant God, praying that the ravages of the insect may be minimized. The introduction of this species into America or Europe would be calamitous. I shall make due acknowledgment of specimens of ants that may be forwarded to me from Canton, and of information respecting the orange insect and specimens.* Here I might conclude this communication, but as Sir John Lubbock has recently added so much to our knowledge of ants, many people in many lands have become curious to study further the habits of this remarkable insect. I append, therefore, a few remarks which will show that the British legislator might find much in China to reward painstaking research.

What Pliny heard respecting a gigantic ant in India the size of an Egyptian wolf, reached China somewhat exaggerated; while an encyclopedia states that red ants are found in the western deserts as big as elephants, and that they kill people! What, however, Chinese writers state concerning the ants of their own country is not incredible. Before they acquired the art of writing, these observant people had noted the most characteristic feature of ants—their orderly submission to authority: and therefore, when writing began they devised a character expressive of this trait of the formica, composed of "insect," and, for the phonetic element, "that which enables the heart to rule itself, the rule of self-dignity and respect, what is proper and just *per se*;" because, says lexicography, the ants have princes and ministers, implying intelligent administration and obedience. A further evidence is furnished of their regard for equity in their uniting to inflict capital punishment on offenders, and in their co-operative and communistic proceedings with regard to food. Patient observations have been made of their subterranean abodes. It has been discovered that they live in cities which have crenelated and carved walls, within which are regular streets, dwellings, galleries, and markets. In one of these cities two magnates were observed, one of a purple color, with wings and legs of golden hue; in another, a regular court was observed, the prince giving audience to a privileged few, menial officers at a distance keeping order. On quitting their nests, they sometimes march five abreast in military rank. They afford prognostics of wet weather, know-

*Since writing the above I have met with a passage in the Botanical Encyclopedia of Heu-kuang-ch'i, the Christian statesman and philosopher (a posthumous work, 1640), which seems to indicate that ants generally may be employed for protecting the orange. Under orange culture he simply directs the placing of ants' nests on tree-tops which, he adds, will drive away the worms that injure that fruit.

ing well when it is about to rain; to protect themselves from deluges they close up the apertures of their nests. In classic times a military leader being in straits for water was advised to observe the position of ants' nests—which in winter are to be found on the southern declivities of hills, and in summer on the northern aspects—and to dig for water where their earthworks were to be seen; and on digging as directed, water was obtained. Their passion for carrion is particularly noticed by native naturalists, and the predacious and pugnacious character of ants is often referred to. They have been seen fighting in pairs, advancing and retreating in duels a whole day and night. Several of their battles have been recorded, having obtained this distinction in consequence of civil commotions that followed, of which they were considered to be portents. In the year 466 A.D., black ants and reddish ants in Shantung fought in great numbers, filling a space forty yards long and four inches wide. The red ants were destroyed. About a century later another great action is recorded between yellow and black ants at Nanking, when the former entirely perished. There is no record of enslavement of black ants by white ants in Chinese natural history. Either slavery has not been observed among them, or they have not attained to that stage of advancement. In battle they show no quarter, whether the fight is among their own or against other colors.

The sudden multiplication of ants has been noticed; but no such disaster is recorded as that in the island of Granada, which a century ago was devastated by this formidable race. In 636 A.D. the capital was amazed by the appearance of ants covering a space of forty yards in length and five to ten feet wide, and piled over each other from six inches to a foot in thickness! Ants of large size, both red and black, abound in the hills of Ningpo, and as their bite is rather poisonous, the inhabitants would suffer greatly from them but for the manis gavanica or pangolin, the scaly ant-eater. The odor of this animal attracts the ants as it lies with all its scales open, beneath which these insects press in swarms; then when the scales close upon them, their captor repairs to his lair, and drops the asphyxiated ants preparatory to their deglutition. These ants are said to be between two and three inches in length, which is not at all incredible if we can believe a statement published respecting a dismissed functionary in Chaou-chou, who sent to his friends in the north an ant pickled in salt, which measured a foot in length!

On the borders of Tungking ants' eggs are so abundant that a picul and a half are sometimes collected by hunters. Perhaps larvæ are meant. They are considered a great dainty, resembling flesh in taste. A certain species of red ant, which makes its nests on tree tops, are also eaten with ginger and salt, used as a condiment. It is very pungent. White ants are used as food, but being no ants at all, but termites, have no place in this note. Ants possess medical properties, and before formic acid was prepared by chemists, they were accordingly used in the West. It is strange that the Chinese pharmacopœia, which abounds in bizarre materials, should not include this insect, unless the "single-footed ant" to be named in the sequel belongs to the formica. Chinese pharmaceutists, however, are aware that ants yield "vinegar," and the earth of ant-mounds, which is probably saturated with the acid or a formica, is an article of materia medica. Ants have been turned to use also in the arts. A brief notice of a varnish-furnishing ant is found in an old work, "Records of the Wu State," in one of the districts of which, Changchou or Suchau, a cottony creeper grows, beneath which ants have their abode. By piercing the ground with the bark of the creeper, ants climb up it, and these produce varnish.

In conclusion I may mention a unique insect which is denominated the "monopedal ant," and which the early *Puntsaw* recommends for boils and ulcers, the insects to be applied locally after being crushed. This "ant" has but a single leg, by which it is permanently attached to the roots of a tree, and it possesses the power of motion without locomotion!

Wenchow, February, 1882.

SARDINE FISHERY.

THE sardine fishery constitutes, in France, a marine industry which plays a considerable part in the prosperity of the littoral population. The port of Douarnenez alone possesses 800 fishing-boats of seven or eight tons, and Concarneau 600; while there are another 600 boats between Brest and Sables d'Olonne. The crew consists of the master, three men, and a boy, making, in all, 25,600 to 30,000 persons engaged in the sardine fishery, while the preservation of the fish affords work to at least an equal number. In 1875 Douarnenez produced 1,325 tons of green-salted sardines, sold as fresh fish. The boats, twenty feet long, are flat in the stern, but raised and pointed at the prow, which gives them great speed, though it exposes them to the danger of capsizing. They have two masts, slightly inclined backward, and square sails of large size, which permit them to take advantage of the slightest breeze. The nets, not weighted with lead, are from 20 to 30 meters long by 6 or 8 wide, made of very fine cord, with meshes of such size that the sardine is caught by the gills. The upper part is floated with corks, which serve to maintain the vertical position of the net.

In the sardine fishery, the bait, which is called *rogue*, plays the principal part. It is a kind of caviare, made from the eggs of the cod preserved in brine, 35,000 barrels of which, representing a value of £70,000, are imported from Norway yearly. There are various indications of the presence of the sardines, floating wreck being a good sign. Large fish, which prey upon them, effect such destruction that the escaping oil frequently rises to the surface and exhales an odor which is perceptible to experienced fishermen. But it is especially the birds hovering round which are the harbingers of a good take. When a gull dips his beak into the water, it is a sign that the sardines are on the surface; and when a kind of gannet, common on the coast of Brittany, dives down from a height, they are at a certain depth below the surface. In this case, the nets are at once let down, and the bait, mixed with sand to cause it to sink, is scattered by the master. If the bait causes the sardines to rise, a few emerald-green flashes appear in the waves, when the fishermen do not spare the bait; and presently the whole shoal rises round the nets. When there are no more fish to be taken, the nets are hauled in, the sardines are taken out and thrown into the hold, and the boats make for shore.

Formerly, a single boat could take as many as 20,000 sardines, but now it is rare to bring in more than from 5,000 to 6,000. The results vary, not only from year to year, but also between two neighboring points on the shore. According to a table prepared by M. Gouillon, there were, at Douarnenez, from 1859 to 1872, three years of good, six years of average, and three years of poor takings.

On landing, the sardines are taken from the boats to the factories in hampers containing about 500, and the preparation begins at once with perfectly fresh sardines. Women cut off the heads, open and clean the fish, and place them, one by one, on stone or marble slabs previously strewed with salt. While this preliminary drying takes place, the fires are lighted, and the purest olive oil is put into immense caldrons. When the oil is in a state of ebullition, the sardines are laid in layers in iron wire baskets provided with handles. These baskets are plunged into the boiling oil, and then placed on shelves covered with sheet zinc to drain, the oil being caught for future use. The fish, when moderately dry, are taken to the large drying-house exposed to the sea breeze, where they remain for a longer or shorter period, according to the state of the atmosphere. On leaving it, they are sorted and put into boxes; the largest are considered as of first quality, while the small are frequently metamorphosed into anchovies.

JERSEY COW LADY MARY.

THE accompanying engraving is from a photograph of the famous old Jersey cow Lady Mary 1148, imported from the Island of Jersey, September, 1868. She was calved 1866, in color a pure gray, with black tongue and switch; very small horns. She lately died, the property of Messrs. Cooper & Maddux, Reading, Ohio. Mr. Cooper furnishes the following particulars concerning this famous old cow:

Lady Mary has given twenty quarts per day at her flush, and had she been tested for butter, in her best days, we are positive she would rank among the best. Her chief value has been in her sons, one of which, Marius, was the sire of some of Mr. Thos. J. Hand's best things, and was sold after three seasons' service for $500 to Churchman & Jackson, of Beach Grove Farm, Indianapolis, where he has left a numerous progeny of very choice quality. Another of her sons, Lord Lawrence, after invaluable work for his breeder, was sold for $400 to Mr. Kirkman, of Nashville, Tenn., where he is distinguishing himself as a getter of heifers of superb promise. Out of fifteen calves gotten by him for his former owner, thirteen were females, all first class. Last

JERSEY COW "LADY MARY."

May, at Mr. Kirkman's sale, five daughters of Lord Lawrence averaged $528, two of them fetching $860 and $800 respectively. Lady Mary was in the first-prize herd, New York State Fair, 1871, also at Philadelphia, 1880, and won first prize in her class at Philadelphia, 1879 and 1880, and first at St. Louis, 1880.—*Country Gentleman.*

BREWERIES IN EUROPE AND THE UNITED STATES.

IT appears from statistics recently compiled at Vienna, that the number of breweries in Great Britain, in 1880, was 26,114; in Germany, 23,940; in the United States, 8,293; in France, 3,100; in Belgium, 2,500; in Austria-Hungary, 2,297; in Holland, 560; in Russia, 460; in Norway and in Switzerland, 400 each; in Denmark and Sweden, 240 each. The quantity of beer produced in Great Britain was about 49 million hectoliters (the hectoliter is equal to about 22 gallons); in Germany about 37 millions; in the United States, 14; in Austria-Hungary, 11; in Belgium, 8; in France, 7; in Russia, 3; in Holland, 2, etc. Russia has the largest breweries, and there is an average production of 6,950 hectoliters to each, Denmark being credited in this respect with 6,250 hectoliters to each brewery; Austria-Hungary, 4,770; the United States, 4,182; France, 2,355; Great Britain, 1,900; Germany, 1,350. Norway has the smallest breweries, with an average of 1 300 hectoliters. The beer production per head of the population is, in liters—in Belgium, 151; Great Britain, 140; Germany, 83; Denmark, 76; Holland, 52; Switzerland, 31; the United States, 30; Austria-Hungary, 29; Norway, 28; France, 20; Sweden, 16; Russia, 4; and Italy, 3. But, although Great Britain is below Belgium in this matter, we have a far larger consumption of spirits, in addition, in comparison with that country.—*London Times.*

SUPERSTITION AS AN AID TO THIEVES.

A GREAT series of robberies have just been discovered in the Winter Palace of the Chinese Emperor and other public buildings in Pekin, the chief booty consisting of several tons of massive bronze, and copper chains heavily plated with gold. The *North China Herald* says that the disclosures are quite unlike those of ordinary theft.

The walls of the palace, like those of the Manchu city, are garnished with bastions, or watch towers, at the corners, and these structures are usually regarded as virtually no more than characteristic decorations—imposing from a distance, but of course a scene of emptiness and neglect and dust inside. It appears now that for years past the imperial bastions have been the lurking place for a gang of thieves, who were protected and assisted by the palace eunuchs. Lights were occasionally observed to flash and gleam from the cannon holes and windows of these towers, an occurrence which seems to have caused the officers of the household to suspect that they must be inhabited. The eunuchs, on being questioned, confirmed the story of the lights, but explained the mystery by saying that the Hu Hsien, or Fox Fairy, was prostrating himself there with his lighted torch. It may be thought incredible that the officers should have been sufficiently imbecile to believe this fable, or that the eunuchs should have dared to trade so far upon the superstition of their superiors. But fox myths are far from being extinct in China or even in Japan. The animal is credited with many marvellous and supernatural attributes, among which is the ability at the age of fifty years to take the form of a woman, and at a hundred that of a young and beautiful girl. He can also become a wizard if he likes, and at the age of a thousand years is admitted into Paradise, where he becomes a celestial being. The Imperial Palace, it appears, is not the only public building where depredations have been carried on. In the great National Library of the Hanlin Yuen hundreds of the imperial editions of standard works have been found to have been subjected to the most remorseless mutilation, all the broad margins of fine white paper having been cut off and sold by the frugal minded custodians of the place. "It is difficult," says the paper already quoted, "to conceive more unpardonable and wanton outrage. But it shows what a rotten condition the whole administration of the Empire must be in."

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